U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB80-110901

Estech General Chemicals Corporation Duette Mine, Manatee County, Florida Resource Document: Surface Water Quality

Conservation Consultants, Inc, Palmetto, FL

Prepared for

Environmental Protection Agency, Atlanta, GA Region IV

Oct 79

PB80-110901

United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, GA 30308

EPA 904/9-79-044H
October 1979

EPA

Environmental Impact Statement

DRAFT

Estech General Chemicals Corporation
Duette Mine
Manatee County, Florida

SURFACE WATER QUALITY

RESOURCE DOCUMENT

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA 904/9-79-044H	2.	3. Recipient's Accession No. PB80-110901

4. Title and Subtitle
Estech General Chemicals Corporation, Duette Mine Manatee County, Florida, Surface Water Quality Resource Document

5. Report Date
October 1979

6.

7. Author(s)
EIS Branch, Region IV, Atlanta, GA

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

Conservation Consultants, Inc
P.O. Box 35
Palmetto, FL 33561

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address

EIS Branch, U.S. EPA
345 Courtland St,
Atlanta, GA 30308

13. Type of Report & Period Covered
Draft EIS

14.

15. Supplementary Notes

16. Abstracts

The Draft Environmental Impact Statement for the Estech General Chemicals (formerly Swift Agricultural Chemical) Duette Mine is enclosed for your review and comment. The document has been prepared pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) (Public Law 91-190) and applicable EPA regulations at 40 CFR Part 6.9. Thirteen volumes of resource document were also prepared. These resource documents comprise the detailed technical evaluations of the alternatives and the proposed action and contain supporting data related to the Draft EIS. While the Draft EIS is a complete document.

17. Key Words and Document Analysis. 17a. Descriptors

Volume H
Surface Water Quality
Duette Mine
Phosphate
NEPA

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 204
	20. Security Class (This Page UNCLASSIFIED	22. Price A10-A01

SURFACE WATER QUALITY

RESOURCE DOCUMENT

Draft Environmental Impact Statement

Swift Agricultural Chemicals Corporation
Duette Mine Site
Manatee County, Florida

October, 1979

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region IV
345 Courtland Street, N.E.
Atlanta, Georgia 30308

Prepared by:

CONSERVATION CONSULTANTS, INC.
Post Office Box 35
Palmetto, Florida 33561

SURFACE WATER QUALITY
RESOURCE DOCUMENT

TABLE OF CONTENTS

Page

PART I - SURFACE WATER QUALITY BASELINE

LIST OF TABLES iv

LIST OF FIGURES vi

1. INTRODUCTION 1

2. WATER QUALITY DATA 4

3. LONG-TERM AND SEASONAL TRENDS 23

4. EXISTING WATER QUALITY 31

4.1 Approach 31
4.2 Upper Manatee River Basin 40

Physical Parameters 40
Major Cations and Anions 43
Macronutrients 47
Metals 50
Toxins/Bacteriological 52

4.3 South Fork Little Manatee River 54

5. SUMMARY 61

5.1 Upper Manatee River Basin 61
5.2 South Fork Little Manatee River 62

PART II - SURFACE WATER QUALITY IMPACT

LIST OF TABLES 64

LIST OF FIGURES 65

1. DESCRIPTION OF PLANT WATER SYSTEM 66

2. COMPOSITION OF DISCHARGE FROM DUETTE MINE 69

3. COMPARISON OF DISCHARGES WITH EFFLUENT LIMITATIONS AND GUIDELINES 76

TABLE OF CONTENTS
(Continued)

Page

4. IMPACT ON STREAM WATER QUALITY 80

  4.1 Comparison with Water Quality Standards 80
  4.2 Predicted Mass Loadings and Concentrations 82
  4.3 East Fork of Manatee River 94

    Nutrients 94
    Biochemical Oxygen Demand 95
    Fluoride 95
    Total Suspended Solids 99
    Total Dissolved Solids 99

  4.4 North Fork of Manatee River 99

    Nutrients 100
    Biochemical Oxygen Demand 100
    Fluoride 101
    Total Suspended Solids 101
    Total Dissolved Solids 102

5. HYPOTHETICAL FAILURE OF CLAY SETTLING AREA EMBANKMENT .. 102

  5.1 Introduction 102
  5.2 Water Quantity Impact 103
  5.3 Water Quality Impact 110

    Effects on Stream Water Quality 111
    Short-Term Impact on Reservoir 113
    Intermediate Term Effects of Suspended Solids Loading of Lake Manatee 115
    Long-Term Effects of Dissolved Constituents 117
    Effects on Water Treatment Plant Capacity 117
    Effects on Radium 226 Levels in Manatee River and Reservoir 119

  5.4 Biological Effects 120

6. MITIGATING MEASURES 123

BIBLIOGRAPHY 127

APPENDICES 129

NOTE:

Effective August 1, 1979, Swift Agricultural Chemicals Corporation changed its name to Estech General Chemicals Corporation.

The preparation of the Draft Environmental Impact Statement was substantially completed at the time of the name change. Therefore, the name of Swift Agricultural Chemicals Corporation (Swift) is used throughout the Draft Environmental Impact Statement and all attendant Resource Documents.

PART I

SURFACE WATER QUALITY BASELINE

SURFACE WATER QUALITY BASELINE
RESOURCE DOCUMENT

LIST OF TABLES

		Page
Table 1-A	Regression Analyses of Water Quality Parameters Against Stream Discharge	3
Table 2-A	Water Quality Sampling Station Locations	6
Table 2-B	Collection Point Numbering System	7
Table 2-C	Ardaman & Associates Water Quality Records for Swift Agricultural Chemicals Corporation Upper Manatee River Basin	8
Table 2-D	Manatee County Health Department Water Quality Data from Monthly and Annual Reports	14
Table 2-E	Florida Department of Environmental Regulation Intensive Water Quality Summary Results	16
Table 2-F	U.S. Geological Survey Water Resource Data, 1976-1978	17
Table 2-G	Conservation Consultants,Inc. Water Quality Records for W. R. Grace & Company	19
Table 2-H	Characteristic Quality of Surface Waters in Adjacent River Basins	22
Table 2-I	Summary of Surface Water Quality Data	24
Table 3-A	Hypothesis Tests for Time Trends in Water Quality Parameters	30
Table 4.1-A	State of Florida and Federal Water Quality Criteria and Effluent Limitations	33
Table 4.1-B	Frequency of Variation with Water Quality Criteria	37

LIST OF TABLES
(Continued)

		Page
Table 4.2-A	Selected pH Data for Adjacent Watersheds	44
Table 4.2-B	Statistical Summary of Water Quality Parameters, Stations 1 through 4 (1977-1978)	46
Table 4.2-C	Fluoride Concentrations in Manatee County Water Treatment and Distribution Systems	48
Table 4.2-D	Concentration of Total Ammonia (NH_3) which Contain an Un-Ionized Ammonia	53
Table 4.3-A	1977 Summary of Average Daily Stream Discharge, Station 1, East Fork Manatee River	56
Table 4.3-B	1977 Summary of Average Daily Stream Discharge, Station 2, North Fork Manatee River	57
Table 4.3-C	1977 Summary of Average Daily Stream Discharge, Station 3, North Fork Manatee River	58
Table 4.3-D	1977 Summary of Average Daily Stream Discharge, Station 4, East Fork Manatee River	59

SURFACE WATER QUALITY BASELINE
RESOURCE DOCUMENT

LIST OF FIGURES

Page

Figure 2-1 Surface Water Sampling Stations 5

Figure 3-1 Time Trend of Nitrate concentration in Manatee River (Station 9) 32

PART I - SURFACE WATER QUALITY BASELINE

1. INTRODUCTION

The proposed Swift Duette Mine contains portions of three major river basins and four watersheds including the North and East Forks of the Manatee River, the South Fork of the Little Manatee River, and the Myakka River. Eighty-six percent of the proposed mine site is drained by the North Fork and East Fork of the Manatee River. Eleven percent of the site is drained to the northwest by the South Fork of the Little Manatee River, and the remaining one percent falls within the Myakka River basin. Fairly extensive wetlands border the streams traversing the proposed site and comprise 17.7 percent of the total land area. Agricultural land uses consist of unimproved rangeland (8136 acres) and improved uses such as citrus and produce crops (1677 acres). Drainage canals in the vicinity have altered flow patterns and water quality from their natural, undisturbed state. These alterations contribute to nutrient enrichment of the region's streams.

Pollutant loadings of streams in the area arise almost exclusively from non-point, agricultural sources. There are presently no industrial or municipal point sources of water pollutants upstream or in the immediate vicinity of the proposed mine site. The nearest point source in the Manatee River basin — a 12,000 gallon per day sewage treatment plant — is some 21 miles downstream of the site (EPA, 1978).

Surface water quality is generally subject to daily as well as seasonal variation. Water quality conditions are closely related to discharge rates of streams on the site which are highly variable. For example, dilution and erosion accompanying storm events in the rainy season tend to lower the concentration of dissolved minerals while increasing the suspended solids concentration. On the other hand, during the dry season, stream base flow seeping through surficial soils coupled with high evaporation and evapotranspiration could increase concentrations of dissolved minerals while maintaining low concentrations of suspended solids. Ardaman and Associates, Inc.'s (1978) hydrologic study of the Duette site examined regression relationships between water quality parameters and stream discharge (Table 1-A). Significant negative correlation coefficients were reported for alkalinity, sodium, sulfate, chloride, and fluoride; hence, as flow increases, the dissolved solids concentration decreases.

Because the great majority of proposed mine site lies within the Manatee River drainage basin this water quality investigation (and others preceding it) focused major attention on the North and East Forks of the Manatee River which converge and flow into Lake Manatee. Water quality of the South Fork Little Manatee River is examined in less detail since it drains a relatively smaller area, and there will be no intentional interference with the stream by the proposed activity.

Lake Manatee is the primary potable water supply serving the majority of the population in Manatee County and a significant portion of Sarasota County (Tampa Bay Regional Planning Council (TBRPC), 1978). A study of water quality conditions in major reservoirs (including Lake Manatee) in the Tampa Bay region was conducted as part of the Areawide Water

Table 1-A Regression Analyses of Water Quality Parameters Against Stream Discharge.

Regression[1]

Parameter	A - Discharge			B - Log Discharge		
	Correlation Coefficient (r)	Variance Explained (r^2)	Statistical Significance	Correlation Coefficient (r)	Variance Explained (r^2)	Statistical Significance
DISSOLVED OXYGEN, mg/l	.48	.23	***	.46	.21	**
CONDUCTIVITY, μmho/cm	-0.35	0.12	**	-.47	.23	***
pH (median)	.05	<.01	NS	-.04	<.01	NS
MAJOR CONSTITUENTS AND RELATED PARAMETERS, mg/l						
CALCIUM, as Ca	-.39	-.16	**	-.42	.18	**
IRON, as Fe	.25	.06	*	.36	.13	**
MAGNESIUM, as Mg	-.31	.10	*	-.32	.10	*
SODIUM, as Na	-.49	.24	***	-.53	.28	***
SULFATE, as SO_4	-.32	.11	*	-.49	.24	***
CHLORIDE, as Cl	-.54	.30	***	-.57	.32	***
FLUORIDE, as F	-.51	.26	***	-.47	.23	***
ALKALINITY, as $CaCO_3$						
Total	-.44	.20	***	-.51	.26	***
TDS at 105°C	-.55	.31	***	-.61	.38	***
MACRONUTRIENTS AND RELATED CONSTITUENTS, mg/l†						
NITROGEN, as N						
Total	-.16	.02	NS	-.20	.04	*
Ammonia	-.17	.03	NS	.00	.00	NS
Nitrate	.19	.04	NS	-.01	<.01	NS
PHOSPHATE, as P						
Total	-.38	.15	**	-.39	.15	**
Ortho	-.46	.21	***	-.47	.22	***
SILICA, as SiO_2	-.09	<.01	NS	.04	<.01	NS
TURBIDITY, NTU	.10	.01	NS	.17	.03	NS
COLOR, PCU	.28	.08	*	.42	.17	**
BOD (5-Day)	.19	.04	NS	.17	.03	NS

Reproduced from best available copy.

---

[1] Water quality parameter as dependent variable vs. Stream Discharge (A) or vs. Log Stream Discharge (B) as independent variable.

[2] Significance Levels: * = >90%; ** = >99%; *** = >99.9% probability that relationship is not due to chance.

NS = Not Statistically Significant.

† = Unless Otherwise Noted.

Source: Ardaman and Associates, 1978.

Quality Management (AWQM) Plan (TBRPC, 1978). That study concluded that water quality in Lake Manatee as of 1975 was good. Acceleration of the natural eutrophication by excessive nutrient loading was identified as the major problem threatening the reservoir's water quality. Runoff from pastures and fertilized cropland in the Lake's watershed is recognized as the major source of these nutrients.

2. WATER QUALITY DATA

Data were collected from numerous private and governmental sources to assess the water quality baseline conditions and to provide a basis for assessing long-term trends in water quality. The map of surface water sampling stations (Figure 2-1) indicates locations where pertinent data were available and are included in the water quality data base. Table 2-A describes the sampling station locations for the numbering system used in this assessment. The corresponding station numbers used by various collecting agencies are given in Table 2-B.

Data collected for the purposes of this assessment and their specific applications are as follows:

- o Ardaman and Associates, Inc. 1977-1978 monthly flow and water quality sampling program conducted for Swift Agricultural Chemicals Corporation (Table 2-C) — basis for description of water quality in North and East Forks Manatee River.

- o Ardaman and Associates, Inc., April and September, 1974, and October, 1976 single event water quality analyses of on-site and downstream waters (Table 2-C) — primarily heavy metals — and phenol determinations not included in Ardaman and Associates, Inc.'s 1977-1978 program.

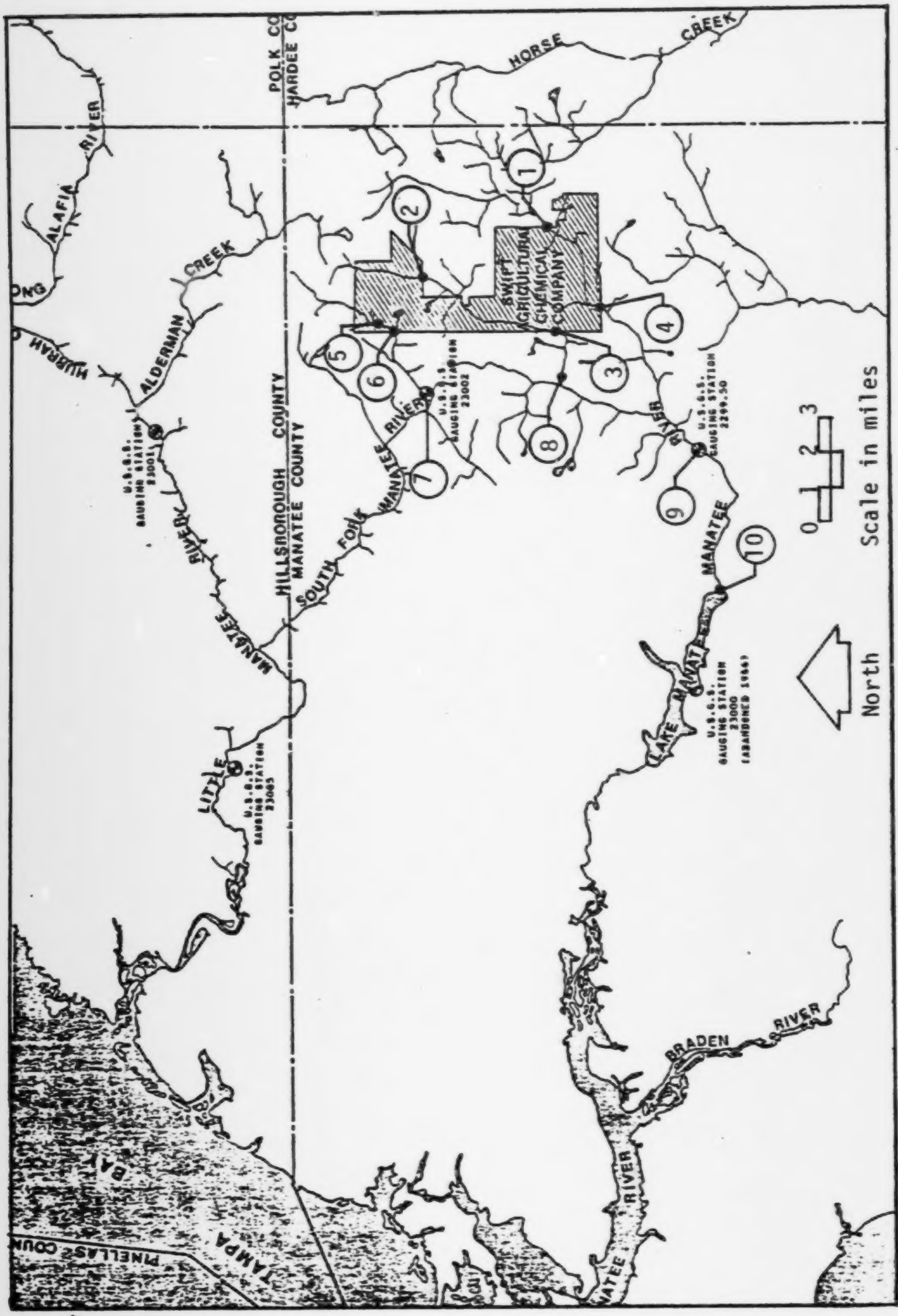

ALAFIA RIVER
HURRAH C
ALDERMAN CREEK
U.S.G.S. GAUGING STATION 23001
MANATEE RIVER
LITTLE
U.S.G.S. GAUGING STATION 23003
HILLSBOROUGH COUNTY
MANATEE COUNTY
POLK CO
HARDEE CO
HORSE CREEK
SOUTH FORK MANATEE RIVER
U.S.G.S. GAUGING STATION 23002
SWIFT AGRICULTURAL CHEMICAL COMPANY
1
2
3
4
5
6
7
8
9
10
RIVER
U.S.G.S. GAUGING STATION 2299.50
MANATEE
LAKE MANATEE
U.S.G.S. GAUGING STATION 23000 (ABANDONED 1966)
BRADEN RIVER
MANATEE RIVER
TAMPA BAY
PINELLAS COUN
North
0 1 2 3
Scale in miles

FIGURE 2-1
SURFACE WATER SAMPLING STATIONS

Table 2-A Water Quality Sampling Station Locations.

Station Identification Number	Description of Location
1	East Fork Manatee River at eastern boundary of site.
2	North Fork Manatee River at eastern boundary of site.
3	North Fork Manatee River at western boundary of site.
4	East Fork Manatee River at southern boundary of site.
5	Uppermost section of site on small tributary to South Fork Little Manatee River.
6	South Fork Little Manatee River at western boundary of site.
7	South Fork Little Manatee River 2.1 miles downstream of site.
8	North Fork Manatee River 1.4 miles downstream of site.
9	Manatee River at State Road 64, approximately 6 miles downstream of site.
10	Manatee River at head of Lake Manatee (Verna Road crossing).

Table 2-B Collection Point Numbering System.

DEIS Station Number	Ardaman & Associates 1978	Ardaman & Associates 1975/1977	U. S. Geological Survey	Florida Department of Environmental Regulation	Manatee County Health Department	Conservation Consultants, Incorporated 1977
1	1	A	--	3	--	--
2	2	D	--	1	--	--
3	3	G	--	--	--	--
4	4	B	--	--	--	--
5	--	F	--	--	--	--
6	--	E	--	--	--	--
7	--	--	02300200	--	--	504
8	--	--	--	2	--	--
9	--	0	02299950	5	MMR-7	--
10	--	N	--	6	MMR-6	--

Table 2-C Ardaman and Associates Water Quality Records for Swift Agricultural Chemicals Corporation Upper Manatee River Basin.

SOURCE	Ardaman & Associates, 1974 Study for Swift Agricultural Chemicals Corporation													
COLLECTION DATE	April 23 and 24, 1974						September 4 and 9, 1974							
PARAMETER / STATION	1	2	3	4	5	6	1	2	3	4	5	6	9	10
Discharge, cfs														
Alkalinity, as $CaCO_3$, Total														
Methyl Orange														
Phenolphthalein														
Carbonate														
Bicarbonate														
Aluminum, as Al														
Arsenic, as As	$<0.02^1$	<0.02	<0.02	<0.02	<0.02	<0.02	<.02	<.01	<.02	<.02	<.02	<.02	<.02	<.02
Biochemical Oxygen Demand	1.8	5.8	5.7	1.9	2.0	1.7	2.3	19	2.2	1.6	14	10	1.5	1.6
Cadmium, as Cd														
Carbon Dioxide, as CO_2														
Chemical Oxygen Demand	15	32	22	22	27	28	26	97	58	39	58	80	38	50
Chloride, as Cl	13.0	11.5	11.0	11.0	15.0	15.5	14.9	13.6	8.4	12.8	24.3	13.5	9.0	7.3
Chromium, as Cr														
Coliform, Fecal (Colonies/100 ml)	30	<1	2000	<1	200	1000	<1	<1	<1	<1	<1	<1	<1	<1
Streptococci	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total	$TNTC^2$	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC
Color, Taylor Units	$Note^3$	$Note^3$	$Note^3$	$Note^3$	$Note^3$	$Note^3$	70	70	70	70	70	70	70	70
Copper, as Cu	0.09	0.01	0.06	0.06	0.07	0.04	.02	0.03	.02	.02	.02	.02	.02	.02
Dissolved Oxygen	8.6	5.4	0.5^4	3.2	8.9	6.6	4.4	0.5	3.8	4.8	10.2	0.4	6.7	5.2
Fluoride, as F	0.4	0.4	0.4	0.4	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Hardness as $CaCO_3$, Total														
Calcium														
Magnesium														
Iron as Fe	0.20	4.88	1.22	0.34	0.34	0.21	0.17	0.20	0.17	0.16	0.20	0.23	0.10	0.08
Lead, as Pb	0.008	0.013	0.009	0.438^4	0.028	0.017	0.004	0.020	0.007	0.006	0.008	0.018	0.017	0.017
Manganese, as Mn														
Mercury, as Hg														
Nickel, as Ni														
Nitrogen, as N, Total	.14	3.84	6.79	0.69	1.69	0.84	2.70	3.49	1.66	2.32	6.21	2.18	0.26	0.42
Organic	<0.05	3.70	2.90	0.60	1.30	0.75	2.25	2.56	1.18	1.97	4.25	1.8	0.05	0.20
Ammonia	<0.05	0.10	3.85^4	0.05	0.35	0.05	0.08	0.75	0.25	0.05	1.6	0.25	0.05	0.10
Kjeldahl														
Nitrate	0.03	0.03	0.03	0.03	0.03	0.03	0.39	0.18	0.24	0.30	0.36	0.12	0.15	0.21
Nitrite	0.0023	0.0043	0.0043	0.0056	0.0043	0.005	<0.001	0.003	<0.001	0.004	<.001	0.004	<0.001	<0.001
Oil and Grease	0.5	0.5	0.5	0.5	0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pesticides/Herbicides, Total	ND^5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	7.22	7.35	7.30	6.90	7.30	7.05	6.90	6.15	6.60	6.95	6.35	6.35	6.20	5.90
pHs														
Phenols														
Phosphorus, as P, Total	0.12	0.42	0.26	0.23	0.13	0.12	0.183	0.43	0.29	0.17	0.27	0.31	0.58	[illegible]
Ortho	0.10	0.02	0.25	0.13	0.08	0.09	0.17	0.27	0.07	0.16	0.16	0.18	0.43	0.43
Potassium, as K	1.2	2.4	3.6	1.0	0.6	0.8	2.8	4.9	1.6	2.1	8.0	3.0	1.3	0.78
Residue, Total Non-filterable	5	150	46	27	60	2	6	42	20	12	69	36	15	21
Total filterable @ 105°C	220	45	237	130	185	218	146	180	117	135	243	164	105	104
Total filterable @ 180°C														
Silica (Dissolved) as SiO_2	0.6	6.9	7.8	2.3	4.4	5.0	3.9	2.9	1.9	4.4	9.7	3.1	5.7	5.0
Sodium, as Na														
Specific Conductance, μmhos/cm	87	120	130	72	110	105	60	60	48	55	100	53	40	30
Stability Index														
Strontium, as Sr														
Sulfates, as SO_4	1.6	0.8	8.4	1.1	14.6	10.8	1.7	<0.1	<0.1	1.0	21.7	<2.7	1.3	1.5
Sulfides, as H_2S	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Surfactants	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Temperature, °C	22.0	22.0	22.0	22.0	25.5	23.0	25.0	26.5	25.0	25.5	34.0	28.0	26.8	25.6
Total Organic Carbon														
Turbidity, JTU	$Note^3$	$Note^3$	$Note^3$	$Note^3$	$Note^3$	$Note^3$	<1.0	14.0	1.0	1.5	15.5	7.5	<1.0	<1.0
Zinc, as Zn	0.092	0.010	<0.005	0.070	0.005	0.013	1.05	0.14	0.03	2.10	0.03	0.09	0.10	0.10

NOTE: See explanation of "superscripts" following Table 2-G.

Table 2- C (Continued).

SOURCE	Ardaman & Associates May/1977 Report to Swift Agricultural Chemicals Corporation, File #74-027								Ardaman & Associates 1977-1978 Hydrologic Monitoring Program for Swift Agricultural Chemicals Corporation								
COLLECTION DATE	October, 1976								May, 1977		June, 1977			July, 1977			
PARAMETER / STATION	1	2	3	4	5	6	10	11	1	4	1	3	4	1	2	3	4
Discharge, cfs									1.1	2.2	1.5	3.5	2.3	2.4	4.8	4.2	11
Alkalinity, as $CaCO_3$, Total									62	66	57	51	56	49	55	60	110
Methly Orange									62	66	57	51	56	49	55	60	110
Phenolphthalein									0	0	0	0	0	0	0	0	0
Carbonate									0	0	0	0	0	0	0	0	0
Bicarbonate									62	66	57	51	56	49	55	60	110
Aluminum, as Al																	
Arsenic, as As																	
Biochemical Oxygen Demand									0.9	1.3	1.6	0.9	2.2	0.5	0.3	0.7	1.0
Cadmium, as Cd																	
Carbon Dioxide, as CO_2									59	64	70	47	51	49	52	57	101
Chemical Oxygen Demand																	
Chloride, as Cl									28	24	24	22	20	21	18	14	13
Chromium, as Cr																	
Coliform, Fecal (Colonies/100 ml)																	
Streptococcii																	
Total																	
Color, PCU									45	25	40	30	20	20	100	45	30
Copper, as Cu									0.2	0.2	0.2	0.7	0.4	0.3	1.2	0.8	0.7
Dissolved Oxygen									5.6	5.8	5.1	3.5	5.0	4.7	2.3	4.2	4.8
Fluoride, as F									0.54	0.52	0.44	0.30	0.42	0.66	0.82	0.44	0.58
Hardness as $CaCO_3$, Total	35.4	24.2	25.9	33.4	25.9	26.1	26.2	26.2	88	72	60	67	47	72	60	44	59
Calcium									72	60	50	58	40	55	45	32	38
Magnesium									16	12	10	9	7	17	15	12	21
Iron as Fe									0.2	0.2	0.3	1.0	0.4	0.2	0.7	0.6	0.4
Lead, as Pb																	
Manganese, as Mn									<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury, as Hg																	
Nickel, as Ni																	
Nitrogen, as N, Total									0.23	0.34	0.85	0.79	0.43	0.87	0.77	0.82	0.80
Organic									0.07	0.10	0.25	0.33	0.09	0.38	0.08	0.28	0.30
Ammonia									0.08	0.07	0.14	0.18	0.08	0.32	0.48	0.36	0.34
Kjeldahl									0.15	0.17	0.39	0.51	0.17	0.70	0.56	0.64	0.64
Nitrate									0.08	0.17	0.45	0.28	0.26	0.17	0.21	0.18	0.16
Nitrite									<0.01	<0.01	0.023	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Oil and Grease									21.4	21.4	14.6	13.4	2.4	5.9	2.2	10.6	10.0
Pesticides/Herbicides, Total																	
pH									6.6	6.7	6.8	6.3	6.3	6.0	5.9	5.9	6.0
pHs									8.65	8.70	8.84	8.87	8.94	8.87	8.93	9.00	8.66
Phenols	14.9	1.46	7.3	12.3	2.4	2.4	2.4	6.1									
Phosphorus, as P, Total									0.38	0.48	0.40	0.68	0.77	0.52	0.68	0.26	0.34
Ortho									0.36	0.43	0.31	0.56	0.68	0.47	0.54	0.25	0.32
Potassium, as K																	
Residue, Total Non-filterable									4	3	2	8	4	4	15	2	4
Total filterable @ 105°C									231	189	173	242	128	177	192	140	142
Total filterable @ 180°C									220	181	155	231	120	162	181	137	129
Silica (Dissolved) as SiO_2									3.4	6.8	4.4	11.0	8.3	10.2	16.5	13.6	12.3
Sodium, as Na									10.7	9.5	9.4	8.6	7.8	10.8	9.4	5.0	7.2
Specific Conductance, µmhos/cm									260	230	205	660	165	201	104	166	134
Stability Index									10.5	10.5	10.9	11.2	11.4	10.9	12.3	12.0	10.9
Strontium, as Sr																	
Sulfates, as SO_4									35.	30	21	25	11	20	6	<5	18
Sulfides, as H_2S																	
Surfactants																	
Temperature																	
Total Organic Carbon																	
Turbidity, NTU									1.5	1.0	2.0	1.7	1.5	1.0	1.0	1.5	1.5
Zinc, as Zn																	

Table 2-C (Continued).

SOURCE	Ardaman & Associates 1977-1978 Hydrologic Monitoring Program for Swift Agricultural Chemicals Corporation															
COLLECTION DATE	August, 1977				September, 1977				October, 1977				November, 1977			
PARAMETER / STATION	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Discharge, cfs	33	0.9	2.2	25	72	38	67	113	12	6.7	8.1	30	12	5.7	3.7	15
Alkalinity, as $CaCO_3$, Total	34	27	19	38	26	25	21	24	39	27	29	33	34	12	20	29
Methly Orange	34	27	19	38	26	25	21	24	39	27	29	33	34	12	20	29
Phenolphthalein	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbonate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	34	27	19	38	26	25	21	24	39	27	29	33	34	12	20	29
Aluminum, as Al																
Arsenic, as As																
Biochemical Oxygen Demand	2.2	1.5	1.3	2.0	1.5	0.7	0.8	1.0	1.1	1.4	0.7	0.4	0.8	0.6	0.3	0.4
Cadmium, as Cd																
Carbon Dioxide, as CO_2	36	32	27	41	29	32	24	29	44	36	39	35	38	25	26	32
Chemical Oxygen Demand																
Chloride, as Cl	19	18	14	18	12	16	11	10	18	16	12	17	24	21	16	21
Chromium, as Cr																
Coliform, Fecal (Colonies/100 ml)																
Streptococcii																
Total																
Color, PCU	220	220	200	200	180	150	160	180	120	150	150	170	120	300	220	180
Copper, as Cu	0.2	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dissolved Oxygen	3.9	5.0	4.6	4.7	3.4	3.2	4.8	4.7	4.6	4.3	4.0	4.2	5.2	3.6	4.4	5.1
Fluoride, as F	0.28	0.32	0.27	0.28	0.27	0.42	0.27	0.21	0.41	0.46	0.42	0.44	0.48	0.46	0.34	0.49
Hardness as $CaCO_3$, Total	50	56	45	56	46	54	50	60	103	137	35	47	67	54	34	52
Calcium	30	34	31	42	34	33	30	40	81	124	21	26	40	42	20	28
Magnesium	20	22	14	14	12	21	20	20	22	13	14	21	27	12	14	24
Iron as Fe	1.8	0.2	0.2	1.6	2.8	3.0		3.2	0.88	0.72	1.23	0.77	0.85	1.28	0.93	0.63
Lead, as Pb																
Manganese, as Mn	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury, as Hg																
Nickel, as Ni																
Nitrogen, as N, Total	0.73	0.76	0.67	4.77	0.43	0.56	0.50	0.76	0.78	0.82	0.63	0.78	1.03	0.94	0.76	0.76
Organic	0.48	0.38	0.38	4.53	0.10	0.09	0.16	0.31	0.21	0.18	0.35	0.15	0.26	0.34	0.09	0.10
Ammonia	0.13	0.22	0.18	0.14	0.21	0.26	0.22	0.28	0.44	0.50	0.16	0.46	0.60	0.44	0.58	0.56
Kjeldahl	0.61				0.31				0.65				0.86			
Nitrate	0.12	0.16	0.10	0.10	0.12	0.21	0.12	0.17	0.13	0.14	0.12	0.17	0.17	0.16	0.09	0.10
Nitrite	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Oil and Grease	5.9	6.1	5.4	1.5	7.2	8.6	6.2	7.6	5.6	4.3	7.9	4.5	6.5	6.2	14.8	12.6
Pesticides/Herbicides, Total																
pH	6.6	6.5	6.2	6.4	6.8	7.1	7.2	6.9	6.4	6.8	6.7	6.7	6.7	6.7	6.5	6.7
pHs	9.27	9.33	9.49	9.08	9.35	9.40	9.50	9.30	8.78	8.77		9.34	9.17	9.60	9.70	9.39
Phenols																
Phosphorus, as P, Total	0.53	0.56	0.64	0.32	0.57	0.48	0.38	0.43	0.44	0.50	0.50	0.39	0.36	0.39	0.38	0.41
Ortho	0.41	0.53	0.43	0.25	0.43	0.39	0.23	0.33	0.37	0.45	0.44	0.35	0.30	0.32	0.36	0.37
Potassium, as K																
Residue, Total Non-filterable	12	8	16	8	2	16	8	4	12	21	10	7	18	21	2	12
Total filterable @ 105°C	147	128	98	122	132	161	138	110	133	156	109	123	148	167	132	146
Total filterable @ 180°C	139	117	89	115	125	153	136	106	130	141	102	119	127	132	116	109
Silica (Dissolved) as SiO_2	6.0	4.7	4.0	4.9	16.1	12.3	11.0	13.1	8.1	12.7	9.3	7.6	8.5	13.1	9.7	7.6
Sodium, as Na	10.6	9.4	5.8	12.4	4.08	7.14	4.83	5.41	7.5	9.2	5.6	7.0	9.0	8.3	6.8	8.8
Specific Conductance, μmhos/cm	106	136	89	105	74	84	70	66	151	156	122	142	155	80	80	140
Stability Index	12.0	12.2	12.8	11.6	11.9	11.7	11.8	11.7	11.2	10.7	12.3	12.0	11.6	12.5	13.1	12.1
Strontium, as Sr																
Sulfates, as SO_4	9	10	<1	6	<1	2	<1	5	12	26	9	11	21	17	<1	<1
Sulfides, as H_2S																
Surfactants																
Temperature																
Total Organic Carbon																
Turbidity, NTU	2.0	1.8	1.6	1.5	1.5	1.0	2.5	1.5	1.6	1.0	2.8	1.8	4.0	2.5	1.5	1.5
Zinc, as Zn																

Table 2-C (Continued).

SOURCE	Ardaman & Associates 1977-1978 Hydrologic Monitoring Program for Swift Agricultural Chemicals Corporation											
COLLECTION DATE	December, 1977				January, 1978				February, 1978			
PARAMETER / STATION	1	2	3	4	1	2	3	4	1	2	3	4
Discharge, cfs	13	14	12	15	44	61	56	--	120	185	132	122
Alkalinity, as $CaCO_3$, Total	29	12	16	27	31	8	22	24	16	7	10	17
Methyl Orange	29	12	16	27	31	8	22	24	16	7	10	17
Phenolphthalein	0	0	0	0	0	0	0	0	0	0	0	0
Carbonate	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	29	12	16	27	31	8	22	24	16	7	10	17
Aluminum, as Al												
Arsenic, as As												
Biochemical Oxygen Demand	4.0	0.6	1.0	1.0	0.8	1.3	1.4	1.0	0.3	2.9	4.0	0.5
Cadmium, as Cd												
Carbon Dioxide, as CO_2	33	23	24	38	35	21	31	29	10	8	8	8
Chemical Oxygen Demand												
Chloride, as Cl	21	19	15	18	20	16	14	18	13.2	9.5	12.0	11.5
Chromium, as Cr												
Coliform, Fecal (Colonies/100 ml)												
Streptococci												
Total												
Color, PCU	150	360	200	100	100	250	180	150	180	200	200	230
Copper, as Cu	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Oxygen	5.2	4.7	5.5	5.7	7.8	7.5	8.0	8.5	6.5	7.0	8.2	7.4
Fluoride, as F	0.43	0.60	0.44	0.40	0.33	0.28	0.27	0.29	0.27	0.27	0.20	0.22
Hardness as $CaCO_3$, Total	60	51	34	45	74	45	31	51	28	18	21	25
Calcium	38	40	24	26	50	42	26	38	14	12	11	13
Magnesium	22	11	10	19	24	3	5	13	14	6	10	12
Iron as Fe	1.1	1.7	1.2	0.9	0.72	1.02	1.2	0.56	1.5	3.1	2.6	2.5
Lead, as Pb												
Manganese, as Mn	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury, as Hg												
Nickel, as Ni												
Nitrogen, as N, Total	0.77	0.92	0.63	0.75	0.69	0.66	0.48	0.57	0.57	0.69	0.69	0.66
Organic	0.25	0.34	0.18	0.14	0.23	0.24	0.15	0.25	0.17	0.19	0.31	0.23
Ammonia	0.41	0.37	0.30	0.49	0.24	0.27	0.20	0.16	0.22	0.26	0.18	0.24
Kjeldahl												
Nitrate	0.10	0.21	0.15	0.12	0.22	0.15	0.13	0.16	0.18	0.24	0.20	0.19
Nitrite	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.01
Oil and Grease	5.9	8.8	7.6	1.7	7.8	7.4	10.1	2.5	6.9	9.9	10.5	6.8
Pesticides/Herbicides, Total												
pH	6.0	5.3	6.0	6.3	7.1	7.2	6.2	6.5	7.2	7.2	7.8	7.6
pHs	9.26	9.61	9.70	9.43	9.00	9.70	9.50	9.30	9.92	10.34	10.24	9.92
Phenols												
Phosphorus, as P, Total	0.39	0.37	0.33	0.33	0.24	0.28	0.27	0.24	0.29	0.34	0.24	0.30
Ortho	0.29	0.35	0.27	0.28	0.19	0.28	0.24	0.20	0.23	0.23	0.15	0.21
Potassium, as K												
Residue, Total Non-filterable	9	1	8	9	9	4	4	3	8	19	14	33
Total filterable @ 105°C	146	144	97	123	137	108	79	131	94	69	71	69
Total filterable @ 180°C	122	118	91	119	130	101	79	108	82	69	69	57
Silica (Dissolved) as SiO_2	7.0	9.5	8.3	7.6	7.6	6.3	7.2	5.5	6.0	8.0	7.0	2.7
Sodium, as Na	9.4	9.5	7.3	8.2	5.6	5.0	5.2	6.3	6.0	5.4	6.8	5.2
Specific Conductance, µmhos/cm	164	101	91	149	163	76	78	139	96	61	76	87
Stability Index	12.4	13.7	13.4	12.3	10.9	12.2	12.7	12.1	12.6	13.5	13.7	12.2
Strontium, as Sr												
Sulfates, as SO_4	16	<1	<1	13	24	< 1	<1	16	13	<1	<1	11
Sulfides, as H_2S												
Surfactants												
Temperature												
Total Organic Carbon												
Turbidity, NTU	1.7	0.6	1.0	1.1	1.8	1.3	3.1	1.9	1.7	1.1	2.3	1.9
Zinc, as Zn												

Table 2-C (Continued).

SOURCE	Ardaman & Associates 1977-1978 Hydrologic Monitoring Program for Swift Agricultural Chemicals Corporation						
COLLECTION DATE	March, 1978				April, 1978		
PARAMETER / STATION	1	2	3	4	1	3	4
Discharge, cfs	24	17	5.8	25	1.2	0.5	2.3
Alkalinity, as $CaCO_3$, Total	38	12	23	33	46	124	77
Methly Orange	38	12	23	33	46	124	77
Phenolphthalein	0	0	0	0	0	0	0
Carbonate	0	0	0	0	0	0	0
Bicarbonate	38	12	23	33	46	124	77
Aluminum, as Al							
Arsenic, as As							
Biochemical Oxygen Demand	--	--	--	--	--	--	--
Cadmium, as Cd							
Carbon Dioxide, as CO_2	8	20	14	6	4	6	6
Chemical Oxygen Demand							
Chloride, as Cl	16.3	15.3	11.8	14.8	20	8.8	17.7
Chromium, as Cr							
Coliform, Fecal (Colonies/100 ml)							
Streptococci							
Total							
Color, PCU	250	350	225	175	50	75	55
Copper, as Cu	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01
Dissolved Oxygen	--	--	--	--	--	--	--
Fluoride, as F	0.38	0.26	0.18	0.24	0.41	0.32	0.33
Hardness as $CaCO_3$, Total	41	33	22	35	91	82	78
Calcium	20	12	12	18	44	40	38
Magnesium	21	21	10	17	47	42	40
Iron as Fe	4.2	3.6	7.6	8.4	0.03	0.11	0.04
Lead, as Pb							
Manganese, as Mn	<0.05	<0.05	<0.05	<0.05	0	<0.15	0
Mercury, as Hg							
Nickel, as Ni							
Nitrogen, as N, Total	0.30	0.38	0.99	0.95	4.21	0.80	3.29
Organic	0.00	0.05	0.41	0.65	3.60	0.63	3.00
Ammonia	0.30	0.33	0.08	0.30	0.50	0.15	0.20
Kjeldahl							
Nitrate	<0.01	<0.01	<0.01	<0.01	0.11	0.02	0.09
Nitrite	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Oil and Grease	4.1	3.8	3.5	1.6	3.7	3.6	2.8
Pesticides/Herbicides, Total							
pH	6.8	5.9	6.5	6.7	6.2	6.7	6.9
pHs	9.37	10.10	11.18	9.49	9.02	8.6	8.82
Phenols							
Phosphorus, as P, Total	0.76	0.86	0.72	0.66	0.30	1.07	0.46
Ortho	0.36	0.47	0.40	0.44	0.22	0.09	0.37
Potassium, as K							
Residue, Total Non-filterable	4	1	4	4	5	2	3
Total filterable @ 105°C	96	90	86	94	197	134	133
Total filterable @ 180°C	96	82	82	94	183	132	124
Silica (Dissolved) as SiO_2	6.8	19.7	6.1	4.3	6.4	15.1	7.1
Sodium, as Na	7.0	6.8	5.8	6.1	8.3	5.0	7.4
Specific Conductance, µmhos/cm	84	48	52	76	230	185	180
Stability Index	11.9	14.3	15.8	12.3	11.8	10.5	10.7
Strontium, as Sr							
Sulfates, as SO_4	11	2.3	0.8	10	42	0.75	16
Sulfides, as H_2S							
Surfactants							
Temperature							
Total Organic Carbon							
Turbidity, NTU	1.7	1.1	1.4	1.7	1.3	1.4	1.3
Zinc, as Zn							

- Manatee County Health Department (MCHD) monthly and/or quarterly water quality records from 1969 through June, 1978 at Station 9 — used to assess long-term water quality trends in the upper one-third of the Manatee River watershed and existing water quality at Station 9 (Table 2-D).

- Manatee County Health Department (MCHD) quarterly records from March, 1976 through March, 1978 at Station 10 (Table 2-D) — describes existing water quality in Lake Manatee.

- Results of Florida Department of Environmental Regulation (FDER) intensive survey of the Manatee River basin in February, 1978 (Table 2-E) — provides mainly heavy metal concentrations in streams at or near the proposed site.

- U.S. Geological Survey discharge and water quality data for Station 7 and 9 as given in U.S.G.S. Water Resources Data for Florida (Water Year 1977), STORET (1970-1976), and unpublished data from Water Year 1978 (Table 2-F) — supplementary to MCHD department data.

- Conservation Consultants, Inc. (CCI), 1976-1978 monthly water quality monitoring reports for W. R. Grace and Company (Table 2-G) — basis for description of water quality in South Fork Little Manatee River.

- U.S. EPA, Central Florida Phosphate Industry Areawide Impact Assessment Program (Table 2-H) — characterization of the quality of surface water in river basins adjacent to the Duette Mine site.

Table 2- D Manatee County Health Department Water Quality Data from Monthly and Annual Reports.

SOURCE	Manatee County Health Department (Annual Reports)								
COLLECTION DATE	1969	1970	1971	1972	1973	1974	1975	1976	1977
PARAMETER / STATION	9	9	9	9	9	9	9	9	9
Discharge, cfs									
Alkalinity, as $CaCO_3$, Total									
Methly Orange									
Phenolphthalein									
Carbonate									
Bicarbonate									
Aluminum, as Al									
Arsenic, as As									
Biochemical Oxygen Demand	1	1	1	1	1	2	1	1.8	1.0
Cadmium, as Cd									
Carbon Dioxide, as CO_2									
Chemical Oxygen Demand									
Chloride, as Cl	13.09	11.16	12.6	10.7	10.2	9.65	14.0	12.9	12.2
Chromium, as Cr									
Coliform, Fecal (Colonies/100 ml)									
Streptococci									
Total									
Color, PCU				55.8	71	86	118	118	150
Copper, as Cu									
Dissolved Oxygen	7.3	7.1	7.5	6.7	7.6	8.2	6.9	5.2	7.1
Fluoride, as F	.45	.19	.25	0.26	0.30	0.82	0.70	0.84	0.22
Hardness as $CaCO_3$, Total	48.02	40.04	43.2	33.5	66.4	42.1	54.5	59.3	41.9
Calcium									
Magnesium									
Iron as Fe									
Lead, as Pb									
Manganese, as Mn									
Mercury, as Hg									
Nickel, as Ni									
Nitrogen, as N, Total									
Organic									
Ammonia									
Kjeldahl									
Nitrate			0.08	0.08	0.06	0.11	0.08	0.11	0.14
Nitrite									
Oil and Grease									
Pesticides/Herbicides, Total									
pH	6.4	6.8	6.7	6.3	6.6	6.4	6.8	6.6	6.7
pHs									
Phenols									
Phosphorus, as P, Total									
Ortho	0.58	0.64	0.59	0.49	0.41	0.69	0.47	0.57	0.47
Potassium, as K									
Residue, Total Non-filterable	3	3	9	1	4	14	21	9	9
Total filterable @ 105°C	108	77	111	93	116	97	99	82	138
Total filterable @ 180°C									
Silica (Dissolved) as SiO_2									
Sodium, as Na									
Specific Conductance, μmhos/cm					176	138	126	172	155
Stability Index									
Strontium, as Sr									
Sulfates, as SO_4									
Sulfides, as H_2S									
Surfactants									
Temperature, °C	21	21	22	21	22	22	21	22	21.4
Total Organic Carbon									
Turbidity, JTU	1.82^6	1.61^6	1.62^6	2.85	3.08	4.4	4.9	2.6	2.1
Zinc, as Zn									

NOTE: See explanation of "superscripts" following Table 2-G.

Table 2-D (Continued).

SOURCE	Manatee County Health Department (Monthly Reports)								
COLLECTION DATE	March 1976	June 1976	Sept. 1976	Dec. 1976	March 1977	June 1977	Sept. 1977	Dec. 1977	March 1978
PARAMETER / STATION	10	10	10	10	10	10	10	10	10
Discharge, cfs									
Alkalinity, as CaCO$_3$, Total									
Methly Orange									
Phenolphthalein									
Carbonate									
Bicarbonate									
Aluminum, as Al									
Arsenic, as As									
Biochemical Oxygen Demand	3	2	1	1	3	6	1	1	1
Cadmium, as Cd									
Carbon Dioxide, as CO$_2$									
Chemical Oxygen Demand									
Chloride, as Cl	11.5	13.5	12.5	14.0	14.0	13.4	8.0	13.5	9.0
Chromium, as Cr									
Coliform, Fecal (Colonies/100 ml)									
Streptococcii									
Total									
Color, PCU	30	200	180	420	110	150	200	75	120
Copper, as Cu									
Dissolved Oxygen	8.3	2.1	2.0	3.0	2.1	0.7	2.6	2.7	4.4
Fluoride, as F	1.05	0.98	0.63	0.26	0.24	0.28	0.13	0.26	0.21
Hardness as CaCO$_3$, Total	107	36.3	409	57.4	68.7	108	31.4	53.0	26.0
Calcium									
Magnesium									
Iron as Fe									
Lead, as Pb									
Manganese, as Mn									
Mercury, as Hg									
Nickel, as Ni									
Nitrogen, as N, Total									
Organic									
Ammonia									
Kjeldahl									
Nitrate	0.07	0.14	0.16	0.06	0.08	0.09	0.20	0.10	0.11
Nitrite									
Oil and Grease									
Pesticides/Herbicides, Total									
pH	6.5	7.0	6.5	6.5	7.5	6.2	6.0	6.5	6.4
pHs									
Phenols									
Phosphorus, as P, Total									
Ortho	0.37	0.38	0.38	0.33	0.38	0.32	0.42	0.33	0.29
Potassium, as K									
Residue, Total Non-filterable	1	12	10	--	11	29	13	8	12
Total filterable @ 105°C	163	143	100	--	146	138	103	202	132
Total filterable @ 180°C	--	--	--	--	--	--	--	--	--
Silica (Dissolved) as SiO$_2$									
Sodium, as Na									
Specific Conductance, μmhos/cm	260	132	80	162	122	159	239	152	94
Stability Index									
Strontium, as Sr									
Sulfates, as SO$_4$									
Sulfides, as H$_2$S									
Surfactants									
Temperature, °C	22	24	25	16	18	25	30	18	18
Total Organic Carbon									
Turbidity, JTU	4.7	1.8	0.8	1.4	1.1	5.9	1.3	0.9	1.8
Zinc, as Zn									

Table 2-E Florida Department of Environmental Regulation Intensive Water Quality Survey Results.

SOURCE	Florida Department of Environmental Reg. Intensive Water Quality Survey				
COLLECTION DATE	February 21-23, 1978				
PARAMETER / STATION	1	2	8	9	10
Discharge, cfs					
Alkalinity, as $CaCO_3$, Total					
Methly Orange					
Phenolphthalein					
Carbonate					
Bicarbonate					
Aluminum, as Al					
Arsenic, as As					
Biochemical Oxygen Demand	1.4	1.6	1.5	1.5	1.3
Cadmium, as Cd	<0.5		<0.5	<0.5	<0.5
Carbon Dioxide, as CO_2					
Chemical Oxygen Demand					
Chloride, as Cl					
Chromium, as Cr	<0.1		<0.1	<0.1	<0.1
Coliform, Fecal (Colonies/100 ml)					
Streptococcii					
Total					
Color, PCU					
Copper, as Cu	0		0	0	<0.01
Dissolved Oxygen	8.0	7.2	7.3	8.4	8.1
Fluoride, as F					
Hardness as $CaCO_3$, Total	35.3		14.6	17.9	21.6
Calcium	22.5		8.8	11.2	12.5
Magnesium	12.8		5.8	8.7	9.1
Iron as Fe	0.22		0.19	0.20	0.20
Lead, as Pb	<0.01		<0.01	<0.01	<0.01
Manganese, as Mn					
Mercury, as Hg, µg/l	<0.2		<0.2	<0.2	<0.2
Nickel, as Ni					
Nitrogen, as N, Total	1.21	0.82	0.85	1.58	1.63
Organic					
Ammonia					
Kjeldahl	0.98	0.76	0.77	1.43	1.39
Nitrate	0.23	0.06	0.08	0.15	0.24
Nitrite	<0.01	<0.01	<0.01	<0.01	<0.01
Oil and Grease					
Pesticides/Herbicides, Total					
pH	6.9	6.2	6.6	6.8	7.3
pHs					
Phenols					
Phosphorus, as P, Total	0.47	0.31	0.16	0.44	0.43
Ortho					
Potassium, as K	2.5		0.6	1.3	1.8
Residue, Total Non-filterable					
Total filterable @ 105°C					
Total filterable @ 180°C					
Silica (Dissolved) as SiO_2					
Sodium, as Na	4.7		4.0	4.2	4.0
Specific Conductance, µmhos/cm	100	60	90	70	80
Stability Index					
Strontium, as Sr					
Sulfates, as SO_4					
Sulfides, as H_2S					
Surfactants					
Temperature, °C	14	14	13	14	16.5
Total Organic Carbon					
Turbidity					
Zinc, as Zn	< 0.01		0.03		

Table 2-F U.S. Geological Survey Water Resource Data, 1976-1978.

SOURCE	U.S. Geological Survey Water Resource Data for Florida, 1977											
COLLECTION DATE	Oct, 1976		Dec/76	Feb/77	March 1977		April 1977		May 1977		June 1977	Sept 1977
PARAMETER / STATION	7	9	7	7	7	9	7	9	7	9	7	7
Discharge, cfs						12.4		2.17		6.48		
Alkalinity, as $CaCO_3$, Total										51		
Methly Orange												
Phenolphthalein												
Carbonate										0		
Bicarbonate										105		
Aluminum, as Al										0.27		
Arsenic, as As										0.001		
Biochemical Oxygen Demand									15	0.5		
Cadmium, as Cd										0		
Carbon Dioxide, as CO_2												
Chemical Oxygen Demand												
Chloride, as Cl										11		
Chromium, as Cr												
Coliform, Fecal (Colonies/100 ml)												
Streptococcii												
Total												
Color, PCU										70		
Copper, as Cu										.003		
Dissolved Oxygen	4.1		11.5	10.8	10.0	10.5	7.8	11.5	4.8	11.5	4.4	6.4
Fluoride, as F										0.4		
Hardness as $CaCO_3$, Total										97		
Calcium										58		
Magnesium										39		
Iron as Fe										0.14		
Lead, as Pb										0.039		
Manganese, as Mn										0		
Mercury, as Hg, μg/l										0		
Nickel, as Ni										.002		
Nitrogen, as N, Total										.24		
Organic										.24		
Ammonia										0		
Kjeldahl										.24		
Nitrate										0		
Nitrite										0		
Oil and Grease												
Pesticides/Herbicides, Total												
pH										8.5		
pHs												
Phenols												
Phosphorus, as P, Total										.68		
Ortho										.65		
Potassium, as K										2.8		
Residue, Total Non-filterable												
Total filterable @ 105°C												
Total filterable @ 180°C										132		
Silica (Dissolved) as SiO_2										4.8		
Sodium, as Na										7.2		
Specific Conductance, μmhos/cm	80		85	150	140	150	97	175	97	219	122	70
Stability Index												
Strontium, as Sr										0.93		
Sulfates, as SO_4										32		
Sulfides, as H_2S												
Surfactants												
Temperature, °C	24		13.5	15.0	18.0	20.0	22.0	22.0	21.5	26.5	28.5	31.5
Total Organic Carbon									6.0	5.0		
Turbidity, NTU												
Zinc, as Zn										.010		

Table 2-F (Continued).

SOURCE	U.S. Geological Survey Water Resource Data for Florida, 1977, 1978										
COLLECTION DATE	Oct. 1977		Nov. 1977	January, 1978		March 1978	Apr 14 1978	Apr 28 1978	May 1978	June 1978	Sept. 1978
PARAMETER / STATION	7	9	7	7	9	7	7	7	9	7	7
Discharge, cfs											
Alkalinity, as $CaCO_3$, Total		11							17		
Methly Orange											
Phenolphthalein											
Carbonate		0							0		
Bicarbonate	22								35		
Aluminum, as Al	0.220								0.260		
Arsenic, as As	0.002								0.001		
Biochemical Oxygen Demand	0.7	1.0					0.4		1.0		
Cadmium, as Cd		0									
Carbon Dioxide, as CO_2											
Chemical Oxygen Demand											
Chloride, as Cl		10							15		
Chromium, as Cr											
Coliform, Fecal (Colonies/100 ml)											
Streptococci											
Total											
Color, PCU	250								140		
Copper, as Cu	0.032								0.001		
Dissolved Oxygen			5.0	8.8	9.4						
Fluoride, as F		0.2							0.2		
Hardness as $CaCO_3$, Total		25							50		
Calcium		14.5							27.5		
Magnesium		10.5							22.5		
Iron as Fe		0.45							0.38		
Lead, as Pb		0.007							0.005		
Manganese, as Mn		0.010							0.010		
Mercury, as Hg, µg/l		< 0.5							< 0.5		
Nickel, as Ni		0.009							0.004		
Nitrogen, as N, Total		0.77				0.95		0.38		1.0	0.73
Organic		0.72				0.83		0.24		0.84	0.52
Ammonia		0.03				0.06		0.06		0.05	0.10
Kjeldahl		0.75				0.89		0.30		0.89	0.62
Nitrate		0.0				0.04		0.07		0.11	0.09
Nitrite		0.02				0.02		0.01		0.01	0.02
Oil and Grease											
Pesticides/Herbicides, Total											
pH					6.2						
pHs											
Phenols											
Phosphorus, as P, Total		0.26				0.38		0.71		0.52	0.86
Ortho		0.26				0.38		0.63		0.52	0.81
Potassium, as K											
Residue, Total Non-filterable											
Total filterable @ 105°C											
Total filterable @ 180°C									132		
Silica (Dissolved) as SiO_2											
Sodium, as Na		5.4							7.2		
Specific Conductance, µmhos/cm			100	79	106						
Stability Index											
Strontium, as Sr		0.120							0.250		
Sulfates, as SO_4											
Sulfides, as H_2S											
Surfactants											
Temperature, °C			24.5	17.5	12.0						
Total Organic Carbon	23	20					8.0		25		
Turbidity, NTU						8.0		1.0		2.0	7.0
Zinc, as Zn		0.010							0.010		

Table 2-G Conservation Consultants, Inc. Water Quality Records for W. R. Grace & Company.

SOURCE	W. R. Grace and Company Water Quality Monitoring Reports														
COLLECTION DATE	Sept. 1976	Oct. 1976	Nov. 1976	Dec. 1976	Jan. 1977	Feb. 1977	March 1977	April 1977	May 1977	June 1977	July 1977	Aug. 1977	Sept. 1977	Oct. 1977	Nov. 1977
PARAMETER / STATION	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Discharge, cfs	.79	0	.7	0	.85-.95	1.0	0	.11	.15			$.00^7$	1.35^7	$.30^7$	-1.0^7
Alkalinity, as $CaCO_3$, Total															
Methly Orange															
Phenolphthalein															
Carbonate															
Bicarbonate															
Aluminum, as Al															
Arsenic, as As															
Biochemical Oxygen Demand	.5	1.4	3.1	1.1	1.2	1.8	1.9	3.3	3.2	1.6	.9	2.7	1.0	1.4	2.2
Cadmium, as Cd															
Carbon Dioxide, as CO_2															
Chemical Oxygen Demand															
Chloride, as Cl	12	5.5	6.5	15	18.8	14.9	19	10	13	15	15	14	11	13	10
Chromium, as Cr															
Coliform, Fecal (Colonies/100 ml)															
Streptococcii															
Total															
Color, PCU															
Copper, as Cu															
Dissolved Oxygen	4.4	4.2	4.8	2.9	8.2	7.2	3.4	5.6	3.9	3.3	3.8	3.8	4.2	4.0	4.0
Fluoride, as F	.47	.36	.52	.48	.44	.50	.52	.48	.52	.54	.33	.29	.28	.39	.45
Hardness as $CaCO_3$, Total															
Calcium															
Magnesium															
Iron as Fe															
Lead, as Pb															
Manganese, as Mn															
Mercury, as Hg															
Nickel, as Ni															
Nitrogen, as N, Total		.36	.43	.73	.26	1.30	.59		.40	.47	.79	.76	.64	.46	.77
Organic				.34	.16							.40			
Ammonia				.22	.00	.11	.17	.18	.10	.14	.30	.18	.25	.18	.14
Kjeldahl	.53			.17		1.22	.39	1.8	.20	.27	.55	.58	.52	.36	.68
Nitrate					.10	.08	.20	.09	.20	.20	.24	.18	.12	.10	.09
Nitrite															
Oil and Grease	4.0	4.8	7.0	5.0	16.9	13.2	20.2	11.9	6.7	7.7	7.0	3.1	2.1	1.8	4.3
Pesticides/Herbicides, Total															
pH	5.6	5.8	6.4	6.4	6.4	5.8	6.0	6.0	6.4	6.4	6.1	6.1	6.0	6.3	6.9
pHs															
Phenols															
Phosphorus, as P, Total	.79	1.0	.52	.49	.78	.80	.79	1.6	.82	.31	.48	.84	.59	.66	1.03
Ortho															
Potassium, as K															
Residue, Total Non-filterable	4	4	2	6	2	11	6	11	5	6	1	4	3	5	8
Total filterable @ 105°C	105	78	99	105	114	117	108	93	85	104	132	93	112	76	121
Total filterable @ 180°C															
Silica (Dissolved) as SiO_2															
Sodium, as Na															
Specific Conductance, µmhos/cm		80	116	92	109	117	110	89	110	108	90	102	70	72	200
Stability Index															
Strontium, as Sr															
Sulfates, as SO_4	0	1	2	4	4	5	1	0	4	16	5	0	1	1	3
Sulfides, as H_2S															
Surfactants															
Temperature															
Total Organic Carbon															
Turbidity, NTU	$<25^8$	$<25^8$	$<25^8$	2.9	1.0	3.5	4.0	3.1	1.2	2.5	3.0	2.0	1.5	2.2	3.0
Zinc, as Zn															

NOTE: See explanation of "superscripts" following Table 2-G.

Table 2-G (Continued).

SOURCE	W. R. Grace and Company Water Quality Monitoring Reports, Continued										
COLLECTION DATE	Dec., 1977	Jan., 1978	Feb., 1978	March, 1978	April, 1978	May, 1978	June, 1978	July, 1978	Aug., 1978	Sept., 1978	Oct., 1978
PARAMETER / STATION	7	7	7	7	7	7	7	7	7	7	7
Discharge, cfs	.20[7]	1.55[7]	- .03[7]	.23[7]		Out of water	Out of water	.54[7]	.26[7]	.26[7]	Out of water
Alkalinity, as $CaCO_3$, Total											
Methly Orange											
Phenolphthalein											
Carbonate											
Bicarbonate											
Aluminum, as Al											
Arsenic, as As											
Biochemical Oxygen Demand	1.4	1.9	1.2	1.1	1.9	3.7	1.2	1.55	1.4	.8	.6
Cadmium, as Cd											
Carbon Dioxide, as CO_2											
Chemical Oxygen Demand											
Chloride, as Cl	16	20	18	16	13	14	12	18	13	9	16.5
Chromium, as Cr											
Coliform, Fecal (Colonies/100 ml)											
Streptococci											
Total											
Color, PCU											
Copper, as Cu											
Dissolved Oxygen	5.3	6.4	6.7	3.5	4.5	4.0	3.9	4.85	3.2	3.0	4.6
Fluoride, as F	.42	.79	.30	.18	.17	.33	.22	.27	.20	.21	.233
Hardness as $CaCO_3$, Total											
Calcium											
Magnesium											
Iron as Fe											
Lead, as Pb											
Manganese, as Mn											
Mercury, as Hg											
Nickel, as Ni											
Nitrogen, as N, Total	1.09	.58	.30	.29	.60	6.15	2.58	.88	1.20	1.07	.87
Organic											
Ammonia	.56	.36	.24	.13	.13	.05	.08	.10	.15	.26	.07
Kjeldahl	.93	.43	.30	.29	.31	6.08	2.48	.84	1.16	.76	.77
Nitrate	.16	.15	<.10	<01	.29	.07	.10	.04	.04	.05	.03
Nitrite											
Oil and Grease	2.5	2.6	3.5	5.9	3.1	2.0	17	3.0	1.0	12.2	2.8
Pesticides/Herbicides, Total											
pH	6.1	5.9	6.9	6.2	6.5	6.1	6.0	5.6	5.7	6.4	6.0
pHs											
Phenols											
Phosphorus, as P, Total	.44	.41	.43	.71	.62	.96	.57	.41	.56	.83	.38
Ortho											
Potassium, as K											
Residue, Total Non-filterable	1	14	10	1	0	3	21	0	4	2	1
Total filterable @ 105°C	109	118	93	103	131	152	212	141	137	244	162
Total filterable @ 180°C											
Silica (Dissolved) as SiO_2											
Sodium, as Na											
Specific Conductance, µmhos/cm	106	88	115	71	119	109	76	90	91	93	105
Stability Index											
Strontium, as Sr											
Sulfates, as SO_4	4	6	8	6.7	10	9	8	7.7	<1.0	4.1	2.9
Sulfides, as H_2S											
Surfactants											
Temperature, °C								24	25	25	19
Total Organic Carbon											
Turbidity, NTU	.9	2.3	.8	1.1	1.1	1.0	1.1	.9	1.5	1.9	11
Zinc, as Zn											

Explanatory Notes for Tables 2-C through 2-G

1. Data expressed in milligrams per liter (mg/l) unless otherwise noted.
2. TNTC indicates 250,000 colonies/100 ml after 24 hours at 35°C.
3. Test not performed.
4. Sample contaminated.
5. ND indicates None Detected.
6. Milligrams/liter of SiO_2.
7. Gauge height.
8. Results in Jackson Candle Turbidity Units.

Table 2-H

CHARACTERISTIC WATER QUALITY FOR STUDY AREA, JANUARY 1970-DECEMBER 1976

Pertinent physical, chemical, and bacteriological parameters from the surface water quality data base are summarized in Table 2-I. For sampling Stations 1 through 10, three statistics of each water quality parameter are given — the average, maximum, and minimum values. To best describe the "existing" water quality conditions, 1976, 1977, and 1978 data were primarily used to compute the averages. Where 1976-1978 data were insufficient (generally less than eight separate determinations), data from previous years (1970 through 1975) were used. However, the entire data base was searched for the minimum and maximum value. Values that do not conform to either State or Federal standards are italicized.

3. LONG-TERM AND SEASONAL TRENDS

Sampling Station 9 at the S. R. 64 crossing of the Manatee River is the only location at which sufficient data are available to analyze long-term water quality trends in the upper Manatee River basin. The Manatee County Health Department (MCHD) has monitored key water quality parameters at Station 9 since 1969. Their program follows a more frequent and consistent sampling routine than either U.S.G.S. or FDER programs at this station. Therefore, MCHD data were used to evaluate long-term water quality trends in the upper Manatee River basin.

Kendall's distribution-free test for independence (Hollander and Wolfe, 1973) was used to determine if significant time trends occurred in average annual concentrations of total dissolved solids, total suspended solids, turbidity, dissolved oxygen, biochemical oxygen demand, nitrate, orthophosphate, and fluoride. Table 3-A summarizes the results of hypothesis tests for time trends and gives a statement of the null hypothesis along with conditions for its acceptance or rejection at the 0.10 level of

Table 2-I Summary of Surface Water Quality Data.

PARAMETER		STATION NUMBER									
		1	2	3	4	5	6	7	8	9	10
Physical Parameters											
Discharge (cfs)	Avg.	28	37	28	36	—	—	0.43	—	56.3	—
	Min.	1.1	0	0	2.2			0		2.17	
	Max.	110	185	132	122			1.0		300	
Dissolved Oxygen*	Avg.	5.2	*4.7*	5.2	5.1	9.6	*3.5*	5.2	—	7.7	*3.7*
	Min.	*3.4*	*2.3*	*3.5*	*4.2*	8.9	*0.4*	*2.9*	7.3	*4.6*	*0.7*
	Max.	7.8	7.5	8.2	8.5	10.2	6.6	11.5	7.3	11.5	8.3
Specific Conductance (μmhos/cm)	Avg.	157	94	152	134	105	79	101	—	149	141
	Min.	74	48	52	66	100	53	70	90	70	80
	Max.	260	156	*660*	230	110	105	260	90	219	239
Turbidity (NTU)	Avg.	1.8	1.3	1.9	1.5	15.5	7.5	2.3	—	4.4	2.2
	Min.	1.0	0.6	1.0	1.0	15.5	7.5	0.8		—	0.9
	Max.	4.0	2.5	3.1	1.9	15.5	7.5	11.0		—	5.9
Total Suspended Solids	Avg.	7	12	7	7	*64*	19	5	—	15	15
	Min.	2	1	2	3	*60*	2	0		0	8
	Max.	18	*150*	*46*	*33*	*69*	*36*	21		27	29
Color (PCU)	Avg.	*122*	*230*	*153*	*126*	—	—	—	—	*143*	*131*
	Min.	20	*100*	30	20	70	70			*80*	75
	Max.	*250*	*360*	*225*	*230*	70	70			*280*	*200*

*All units in milligrams per liter unless otherwise noted.

Italicized numbers indicate variations with State and/or Federal water quality standards.

Table 2-I (Continued).

PARAMETER		STATION NUMBER 1	2	3	4	5	6	7	8	9	10
Major Cations and Anions:											
pH	Avg.	6.6	6.3	6.5	6.6	6.8	6.7	6.2	—	6.6	6.5
	Min.	6.0	*5.5*	6.0	6.4	6.3	6.3	*5.7*	6.6	6.2	6.0
	Max.	6.8	7.1	7.1	6.9	7.3	7.0	6.9	6.6	7.5	7.5
Calcium, as $CaCo_3$	Avg.	44.0	42.8	27.5	34.0	—	—	—	—	27.8	—
	Min.	14.0	12.0	10.8	13.2				8.8	11.2	12.5
	Max.	81.2	124	58.0	60.0				8.8	58.0	12.5
Magnesium, as $CaCo_3$	Avg.	21.0	14.0	14.0	18.5	—	—	—	—	20.2	—
	Min.	9.5	3.3	4.9	7.0				5.8	8.7	9.1
	Max.	47.4	21.8	42.4	39.6				5.8	39.0	9.1
Sodium, as Na	Avg.	8.2	7.8	6.1	7.6	—	—	—	—	6.0	—
	Min.	4.1	5.0	4.8	5.2				4.0	4.2	4.0
	Max.	10.8	9.5	8.6	12.4				4.0	7.2	4.0
Chloride, as Cl	Avg.	20	17	14	17	20	14	14	—	12	12
	Min.	12	10	9	10	15	13	9		8	8
	Max.	28	21	22	24	24	15	20		14	14
Sulfate, as SO_4	Avg.	19	7	4	12	18	7	5	—	16	—
	Min.	0	0	0	0	14	3	0		1.3	1.5
	Max.	42	26	25	30	21	11	16		32	1.5
Fluoride	Avg.	0.41	0.43	0.31	0.37	0.35	0.35	0.34		0.42	0.45
	Min.	0.27	0.26	0.18	0.21	0.20	0.20	0.17	—	0.15	0.13
	Max.	0.66	*0.82*	0.44	0.58	0.50	0.50	0.54	—	*0.84*	*1.05*
Alkalinity, as $CaCo_3$	Avg.	38	21	36	45	—	—	—	—	*14*	—
	Min.	*16*	*7*	*10*	*17*					*11*	
	Max.	62	55	124	110					*17*	

Table 2-I (Continued).

PARAMETER		STATION NUMBER									
		1	2	3	4	5	6	7	8	9	10
Major Cations and Anions											
Total Dissolved Solids	Avg.	151	135	121	126	214	191	125		135	144
	Min.	94	69	71	69	185	164	76	—	85	103
	Max.	231	192	242	189	243	218	244		177	202

Table 2-I (Continued).

		STATION NUMBER									
		1	2	3	4	5	6	7	8	9	10
Metals											
Copper, as Cu	Avg.	< *0.13*	< *0.23*	*0.22*	*0.18*	< 0.04	< 0.03	—	—	< 0.013	—
	Min.	< 0.01	< 0.1	< 0.01	< 0.01	< 0.02	< 0.02		0	0	< 0.02
	Max.	*0.3*	*1.2*	*0.8*	*0.7*	*0.07*	*0.04*		0	*0.032*	< 0.02
Iron, as Fe	Avg.	*1.2*	*1.7*	*1.7*	*1.6*	0.27	0.22	—	—	0.25	0.14
	Min.	0.0	0.2	0.1	0.0	0.20	0.21		0.19	0.10	0.08
	Max.	*4.2*	*3.6*	*7.6*	*8.4*	*0.34*	0.23		0.19	*0.45*	0.20
Manganese, as Mn	Avg.	< 0.08	< 0.09	< 0.06	< 0.08	—	—	—	—	.0067	—
	Min.	0	< 0.05	< 0.05	0					0	
	Max.	< 0.5	< 0.5	*0.15*	< 0.5					0.01	
Zinc, as Zn	Avg.	< 0.384	*0.08*	< 0.018	*1.08*	0.018	*0.052*	—	—	0.03	—
	Min.	< 0.01	0.01	< 0.005	*0.07*	0.005	0.013		0.03	0.01	*0.10*
	Max.	*1.05*	*0.14*	0.03	*2.10*	0.030	*0.090*		0.03	*0.10*	*0.10*
Lead, as Pb	Avg.	< 0.007	0.016	0.008	*0.222*	0.018	0.018	—	—	0.0156	.007
	Min.	0.004	0.013	0.007	0.006	0.008	0.017		< 0.01	0.005	.004
	Max.	< 0.01	0.020	0.009	*0.438*	0.028	0.018		< 0.01	*0.039*	.010
Mercury, as Hg (μg/l)	Avg.	—	—	—	—	—	—	—	—	< 0.4	—
	Min.	< 0.2							< 0.2	< 0.2	< 0.2
	Max.	< 0.2							< 0.2	< 0.5	< 0.2

Table 2-I (Continued).

PARAMETER		STATION NUMBER									
		1	2	3	4	5	6	7	8	9	10
Macro nutrients											
Nitrogen, as N Total	Avg.	0.96	0.72	0.66	1.24	3.95	1.51	1.05	—	1.58	1.02
	Min.	0.23	0.38	0.48	0.34	1.69	0.84	0.26	0.85	0.77	0.42
	Max.	4.21	0.94	0.82	4.77	6.21	2.18	6.15	0.85	2.40	1.63
Organic	Avg.	0.50	0.21	0.30	0.82	2.78	1.28	0.30	—	0.51	—
	Min.	0	0.05	0.09	0.09	1.30	0.75	0.4		0.05	0.20
	Max.	3.60	0.38	0.63	4.53	4.25	1.80	6.03		0.72	0.20
Ammonia	Avg.	0.30	0.35	0.24	0.28	0.98	0.15	0.18	—	0.43	—
	Min.	0.08	0.22	0.08	0.07	0.35	0.05	0.05		0	0.10
	Max.	0.60	0.50	0.58	0.56	1.60	0.25	0.56		0.05	0.10
Nitrate	Avg.	0.15	0.16	0.13	0.14	0.20	0.08	0.12	—	0.12	0.12
	Min.	0.00	0.00	0.00	0.00	0.03	0.03	0.01	0.08	0.02	0.06
	Max.	0.45	0.24	0.28	0.26	0.36	0.12	0.29	0.08	0.18	0.20
Phosphorus, as P Total	Avg.	*0.43*[a]	*0.50*	*0.50*	*0.43*	*0.20*	*0.22*	*0.68*	—	*0.46*	*0.48*
	Min.	*0.24*	*0.28*	*0.24*	*0.24*	*0.13*	*0.12*	*0.31*	*0.16*	*0.26*	*0.43*
	Max.	*0.76*	*0.86*	*1.07*	*0.77*	*0.27*	*0.31*	*1.60*	*0.16*	*0.68*	*0.53*
Ortho	Avg.	0.33	0.40	0.31	0.35	0.12	0.14	0.58	—	0.44	0.35
	Min.	0.19	0.23	0.09	0.20	0.08	0.09	0.26		0.26	0.29
	Max.	0.47	0.54	0.56	0.68	0.16	0.18	0.63		0.65	0.48
Total Nitrogen/Total Phosphorus Ratio	Avg.	2.70	1.72	1.63	3.30	18.0	7.0	1.54	—	1.79	2.29
	Min.	0.60	0.44	0.68	0.56	13.0	7.0	0.33	5.31	0.35	0.79
	Max.	14.0	2.49	3.15	14.9	23.0	7.0	6.41	5.31	3.59	3.79

[a] In excess of maximum 0.050 mg/l concentration recommended by EPA (1976) for streams.

Table 2-I (Continued).

PARAMETER		STATION NUMBER									
		1	2	3	4	5	6	7	8	9	10
BOD (5-day)	Avg.	1.4	1.2	1.2	1.0	8.0	5.8	1.7	—	1.1	2.2
	Min.	0.3	0.3	0.3	0.4	2.0	1.7	0.6	1.5	0.5	1.0
	Max.	4.0	2.9	4.0	2.2	16	10	3.7	1.5	2.0	6.0
Fecal Coliform (Colonies/100 ml)	Avg.	< 16	< 1	*1000*	< 1	100	*500*	—	—	*241*	*672*
	Min.	< 1	< 1	< 1	< 1	< 1	< 1			40	8
	Max.	30	< 1	*2000*	< 1	200	*1000*			*1100*	*2400*
Total Coliform (Colonies/100 ml)	Avg.	*TNTC**	*TNTC*	*TNTC*	*TNTC*	*TNTC*	*TNTC*	—	—	*6960*	—
	Min.	*TNTC*	*TNTC*	*TNTC*	*TNTC*	*TNTC*	*TNTC*			*1100*	
	Max.	*TNTC*	*TNTC*	*TNTC*	*TNTC*	*TNTC*	*TNTC*			*19,000*	
Phenols (μg/l)	Avg.	—	—	—	—	—	—	—	—	—	—
	Min.	*14.9*	*14.6*	*7.3*	*12.3*	*2.4*	*2.4*			*2.4*	*6.1*
	Max.	*14.9*	*14.6*	*7.3*	*12.3*	*2.4*	*2.4*			*2.4*	*6.1*

* *TNTC* denotes 250,000 Colonies/100 ml after 24 hours at 35°C

Table 3- A

Hypothesis Tests for Time Trends in Water Quality Parameters.

Hypothesis, Ho, being tested: Parameter X is independent of time or, stated otherwise, a time trend does not exist.

For a two-sided test of Ho at the 0.10 level of significance,

reject Ho if

$$K \geq k\ (0.05, n) \text{ or } K \leq -k\ (0.05, n)$$

accept Ho if

$$-k\ (0.05, n) < K < k\ (0.05, n)$$

Parameter	Number of Observations, n	Kendall's Statistic, K	k (0.05,n)
Total Dissolved Solids	9	- 6	17
Total Suspended Solids	9	-16	17
Turbidity	6	3	10
Dissolved Oxygen	9	5	17
BOD_5	9	- 7	17
Nitrate	7	-13	12
Ortho-phosphate	9	-11	17
Fluoride	9	-12	17

significance. The results show that of the eight parameters, only nitrate exhibits a time trend with 90 percent or greater certainty. The increasing trend of nitrate shown graphically in Figure 3-1 reflects the increasing influx of nitrogen to the Manatee River from agricultural sources.

Data were insufficient to test for meaningful long-term trends in the South Fork Little Manatee River northwest of the site.

Very few water quality parameters measured on-site exhibited seasonal trends. With the relatively small data base (approximately 12 measurements per station) the strong influence of individual rainfall events on water quality tends to obscure what seasonal influence might exist. This observation on seasonal variability in water quality is reinforced by similar observations of the South Fork Little Manatee River as it crosses W. R. Grace property west of the proposed site (Table 2-G).

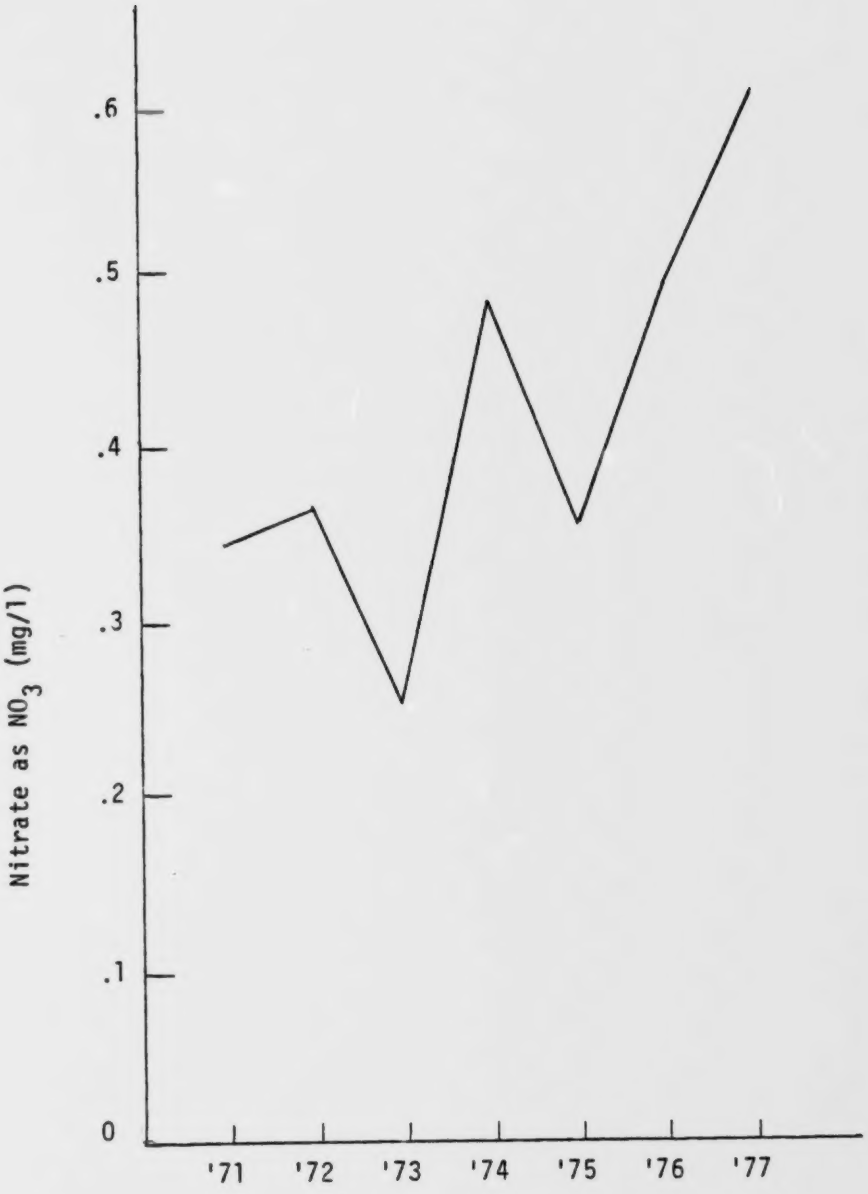
4. EXISTING WATER QUALITY

4.1 Approach

A key aspect of the water quality baseline is an evaluation of the conformance of existing water quality conditions with State of Florida and Federal criteria. A compilation of applicable State and Federal water quality standards and criteria is provided in Table 4.1-A.

The recently revised Chapter 17-3 of the Florida Administrative Code (F.A.C.) — Water Quality Standards (effective March 1, 1979) contains three sets of surface water quality standards which are applicable to waters affected by the proposed project: (1) Section 17-3.061, General

Figure 3-1 Time Trend of Nitrate concentration in Manatee River (Station 9)



Data Source: Manatee County
Health Department

Level of Significance: 0.07

Table 4.1-A State of Florida and Federal Water Quality Criteria and Effluent Limitations

Parameter	F.A.C. 17-3 General Criteria	F.A.C. 17-3 Class I-A	F.A.C. 17-3 Class III	F.A.C. 17-22 Water Supplies	NIPDWR^2 40 CFR 141	USEPA Water Quality Criteria	Phosphate Rock Mining 40 CFR 436 Subpart R
Alkalinity, Total as $CaCO_3$ (min.)	--	20	20	--	--	20	--
Alkalinity, Phenol-pathalein	--	20	20	--	--	20	--
Alkyl Benzene Sulfonate	--	--	--	0.5	--	--	--
Aluminum	--	--	1.5	--	--	--	--
Ammonia (unionized)	--	0.02	0.02	--	--	0.02	--
Antimony	--	--	0.2	--	--	--	--
Arsenic	0.05	--	--	0.01	0.05	0.05	--
Bacteriological (Coliform, Total and Fecal)	--	1000/100ml. Tot. 200/100ml. Fec.	1000/100ml.Tot. 200/100ml. Fec.	Note 1	1 Coliform/ 100 ml	200/100ml. fecal	--
Barium	--	1.0	--	1.0	1.0	1.0	--
Beryllium	--	0.011	0.011		--	0.011(Softwater) 1.100(Hardwater)	--
BOD (5-day)	Note 4	--	--	--	--	--	
Boron	--	--	--	--	--	0.750	
Cadmium, µg/l	--	0.8	0.8	10	10	10(Health) 12(Aquatic life softwater)	--
Carbon Chloroform extract	--	--	--	0.2	--	--	--
Chloride	Marine Only	250	--	250	--	--	--
Chlorine	--	0.010	0.010	0.05	--	0.010	--
Chromium (Total)	0.05	--	--	15	0.05	0.050	--
Color (PCU)	--	--	--	1.0	--	75 (Health)	--
Copper	0.5	0.030	0.030	1.0	--	1.0	--
Cyanide (Total), µg/l	--	0.5	5	--	--	5	--
Detergents (Surfactants)	0.5	--	--	--	--	--	--
Dissolved Oxygen (min.)	--	5	5	--	--	5.0	--
Dissolved Solids	--	500 mon. avg. 1000 anytime	--	500	--	--	--

Table 4.1-A (Continued)

Parameter	F.A.C. 17-3 General Criteria	F.A.C. 17-3 Class I-A	F.A.C. 17-3 Class III	F.A.C. 17-22 Water Supplies	NIPDWR^2 40 CFR 141	USEPA Water Quality Criteria	Phosphate Rock Mining 40 CFR 436 Subpart R
Fluoride	10.0	1.5	Marine Only	0.8	1.4	--	--
Hydrogen Sulfide	--	--	--	--	--	0.002	--
Iron	--	0.3	1.0	0.30	--	0.30	--
Lead	0.05	0.03	0.03	0.05	0.05	0.05	--
Manganese	--	--	--	0.05	--	0.05	--
Mercury, µg/l	--	0.2	0.2	--	2	2 (Health) 0.5 (Freshwater life)	--
Nickel	--	0.1	0.1	--	--	0.1	--
Nitrogen, Ammonia - N (Total)	--	--	--	--	--	--	--
Nitrogen, Kjeldahl - N	--	--	--	--	--	--	--
Nitrogen, Nitrate - N	--	10	--	10	10	10	--
Nitrogen, Nitrite - N	--	--	--	--	--	--	--
Nitrogen, Total - N	--	--	--	--	--	--	--
Odor (Threshold)	--	--	--	3.0	--	--	--
Oils and Grease	5.0	--	--	--	--	0 (Domestic water, supply)	--
Pesticides/Herbicides Scan							
Aldrin + Dieldrin, µg/l	--	0.003	0.003	--	--	0.003	--
Chlordane, µg/l	--	0.01	0.01	--	--	0.01	--
2, 4 - D	--	0.1	--	--	0.1	0.10	--
2, 4, 5 TP, µg/l	--	10	--	--	10	10	--
DDT, µg/l	--	0.001	0.001	--	--	0.001	--
Demeton, µg/l	--	0.1	0.1	--	--	0.1	--
Endosulfan, µg/l	--	0.003	0.003	--	--	0.003	--
Endrin, µg/l	--	0.004	0.004	--	0.2	0.2 (Health) 0.004 (Aquatic life)	--
Guthion, µg/l	--	0.01	0.01	--	--	0.01	--
Heptachlor, µg/l	--	0.001	0.001	--	--	1.0	--
Lindane, µg/l	--	0.01	0.1	--	4	4.0 (Health) 0.01 (Freshwater life)	--
Malathion, µg/l	--	0.1	0.1	--	--	0.1	--
Methoxychlor, µg/l	--	0.03	0.03	--	100	0.03	--
Mirex, µg/l	--	0.001	0.001	--	--	0.001	--
Parathion, µg/l	--	0.03	0.04	--	--	0.04	--
Toxaphene, µg/l	--	0.005	0.005	--	5.0	0.005	--

Table 4.1-A (Continued)

Table 4.1-A (Continued).

Parameter	F.A.C. 17-3 General Criteria	F.A.C. 17-3 Class I-A	F.A.C. 17-3 Class III	F.A.C. 17-22 Water Supplies	NIPDWR[2] 40 CFR 141	USEPA Water Quality Criteria	Phosphate Rock Mining 40 CFR 436 Subpart R
pH	6.0-8.5	--	6.0-8.5	--	--	6.5-9.0	6.0-9.0
Phenols	0.001	--	--	0.001	--	0.001	--
Phthalate Esters	--	0.003	0.003	--	--	0.003	--
Phosphate, Total as P	--	--	--	--	--	0.050	--
Polychlorinated biphenyls µ g/l	--	0.001	0.001	--	--	0.001	--
Radioactivity							
Gross α - activity pCi/L[5]	15	--	--	--	15	--	--
Radium - 226 pCi/L	5	--	--	--	5	--	--
Radium - 228 pCi/L	5	--	--	--	5	--	--
Uranium	--	--	--	--	--	--	--
Selenium	--	0.01	0.025	0.01	0.01	0.01	--
Silver µg/l	--	0.07	0.07	50	50	50	--
Specific Conductance µmho/cm	100% increase 500 max.	--	--	--	--	--	--
Sulfate	--	--	--	250	--	--	--
Total Suspended Solids	--	--	--	--	--	Note 8	60 max. 30 average daily
Trihalomethanes							
Chloroform	--	--	--	--	--	--	--
Bromodichloromethane	--	--	--	--	--	--	--
Chlorodibromomethane	--	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--	--
Total Trihalomethanes	--	--	--	--	0.10	--	--
Turbidity	50 JTU	--	--	5 JTU	1.0 NTU	--	--
Zinc	1.0	0.03	0.03	5	--	5	--

---

1 See F.A.C. Chapter 17-22 for details
2 In milligrams/liter unless otherwise noted
3 National Interim Primary Drinking Water Regulations
4 Sufficiently low to keep dissolved oxygen within limits
5 µg/l = micrograms per liter.
6 pCi/l - picoCuries per liter
7 Hexavalent (Cr^{+6})
8 Ten percent maximum reduction in compensation depth from seasonal norm.

Criteria; (2) Section 17-3.091, Class I-A Waters — Potable Water Supplies, and (3) Section 17-3.121, Class III Waters — Recreational-Propagation, Management of Fish and Wildlife. Water quality data were also evaluated with respect to drinking water standards in F.A.C. Chapter 17-22, Water Supplies.

In addition to comparisons with State standards, variations with the following Federal water quality criteria and effluent limitations were examined. The Federal criteria are: (1) National Interim Primary Drinking Water Regulations (NIPDWR), 40 CFR 141 and (2) U.S. EPA Quality Criteria for Water (1976), "Redbook". Like the F.A.C. Chapter 17-22 standards, the NIPDWR standards apply only to finished water — not to raw water sources.

EPA's quality criteria for water were formulated to offer broad protection to all of the Nation's waters. EPA recognizes that some of the criteria may be exceeded in some natural, unpolluted waters supporting stable ecosystems due to the geographic variability in water quality and the adaptability of organisms to diverse environments (U.S. EPA, 1976). This examination of variation with standards is, therefore, made in part to identify those constituents whose naturally occurring levels exceed the Federal and/or State standards and criteria.

The frequency with which measured parameters at each station vary with State and Federal standards and effluent limitations is summarized in Table 4.1-B. In addition to noting the absolute number of variations, the total number of individual determinations is given (in parenthesis). The percentage of measurements at variance with the standard is thereby readily determinable. Furthermore, the level of certainty that can be

Table 4.1-B Frequency of Variation with Water Quality Criteria.

Parameter (Agency/Criterion)	Station Identification Number								
	1	2	3	4	5	6	7	9	10
Physical Parameters									
Dissolved Oxygen (FDER, EPA/5.0*)	5 (12)**	6 (10)	8 (11)	6 (12)	0	1 (2)	23 (36)	1 (13)	8 (11)
Specific Conductance (FDER/500 µmhos/cm)	0	0	1 (13)	0	0	0	0	0	0
Total Suspended Solids (EPA/60 max; 30 avg. daily)	0 0	1 (11) 2 (11)	0 1 (13)	0 1 (14)	1 (2) 2 (2)	0 1 (2)	0 0	0 0	0 0
Color (F.A.C. 17-22/75 PCU)	14 (14)	11 (11)	13 (13)	14 (14)	2 (2)	2 (2)	–	12 (12)	9 (9)
Major Cations and Anions									
pH (FDER/6.0-9.0)	0 (14)	3 (11)	1 (13)	0 (14)	0 (2)	0 (2)	6 (26)	0 (20)	1 (11)
Fluoride (FDER/0.8)	0	1 (11)	0	0	0	0	0	2 (20)	2 (10)

* Units in milligrams/liter unless otherwise noted.
** Numbers in parentheses denote the total number of determinations
– denotes either no data or inconclusive results

Table 4.1-B (Continued).

Parameter (Agency/Criterion)	Station Identification Number								
	1	2	3	4	5	6	7	9	10
Alkalinity (FDER,EPA/20 min.)	1 (12)	5 (9)	3 (11)	1 (12)	—	—	—	2 (2)	--
Metals									
Copper (FDER/0.030)	5 (6)	1 (3)	3 (4)	4 (5)	1 (1)	1 (1)	—	1 (4)	0
Iron (FDER/0.30)	8 (14)	9 (11)	9 (12)	11 (14)	1 (2)	0	—	2 (5)	0
Manganese (EPA,FDER/0.05)	0	0	1 (11)	0	—	—	—	0	—
Zinc (FDER/0.03)	2 (2)	1 (2)	0	2 (2)	0	1 (2)	—	1 (4)	1 (1)
Lead (FDER/0.03)	0	0	0	1 (2)	0	0	0	1 (4)	0

Table 4.1-B (Continued).

Parameter (Agency/Criterion)	Station Identification Number								
	1	2	3	4	5	6	7	9	10
Macronutrients									
Phosphorous, Total (EPA/0.05)[a]	14 (14)	11 (11)	13 (13)	14 (14)	2 (2)	2 (2)	30 (30)	20 (20)	11 (11)
Ammonia (un-ionized) (FDER,EPA/0.02)	0	0	1 (13)	0	0	0	0	0	0
Phenols (FDER,EPA/1.0 μg/l)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	—	1 (1)	1 (1)
Fecal Coliform (FDER/200/100 ml)	0	0	1 (2)	0	0	1 (2)	0	6 (17)	3 (7)
Total Coliform (FDER/1000/100 ml)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	—	11 (11)	3 (3)

[a] In excess of maximum 0.050 mg/l concentration recommended by EPA (1976) for streams.

attached to observed variations depends to some degree on the size of the sample population. For example, three variations from some standard in a sample of twelve measurements is a more reliable indication of true variation than, say, one observed variation in four measurements.

4.2 Upper Manatee River Basin

Physical Parameters - Instantaneous discharge measurements at Station 2 (see Table 2-C) exemplify the wide variability in stream flow on the proposed site. In seven of twelve months from May, 1977 to April, 1978 discharge was either zero or less than 20 percent of the average monthly discharge of 37 cfs. At the other extreme, the discharge measured February 20, 1978 was 185 cfs — 5 times greater than the mean.

Mean dissolved oxygen (D.O.) concentrations at Station 1 through 4, ranged from 4.7 to 5.2 mg/l (Table 2-I). Fifty-six percent of the individual determinations at Stations 1 through 4 fell below the State and Federal stream standard of 5.0 mg/l. The lowest value reported by Ardaman and Associates (1978) at any of the four stations was 2.3 mg/l at Station 2 in July, 1977. However, on August 31, 1978 a D.O. concentration of 0.05 mg/l was measured during a stream metabolism study (Biota baseline report). These data are contrasted by an average D.O. concentration of 7.7 mg/l measured by the Manatee County Health Department at Station 9, six miles downstream of the site (Table 2-I).

Average BOD_5 levels at the on-site stations ranged from 1.0 to 1.4 — too low to explain the depressed levels of dissolved oxygen. Undoubtedly, the dependence of D.O. on water temperature is one factor contributing to its low concentrations. Sharp declines in D.O. were observed at all stations in the summer months while distinct increases occurred in the winter months.

Ardaman and Associates, Inc. (1978) reported that dissolved oxygen had a positive correlation with flow (correlation coefficient = 0.48, Table 1-A) which confirms that low reaeration rates are contributing to low D.O. concentrations. Low discharge rates and, hence, low stream velocities experienced during the dry season tend to reduce oxygen exchange at the air/water interface (low reaeration coefficient) and thereby depress the equilibrium concentrations of dissolved oxygen. The reverse effect, that is, enhanced reaeration occurs during high flow periods.

A possible third mechanism contributing to the lower than normal D.O. levels is photochemical oxidation of organic coloring agents by D.O. (Ardaman and Associates, Inc., 1978).

Turbidity levels in the on-site streams are consistently low. However, the mean organic color levels exceeded the maximum recommended level (75 Platinum-Cobalt Units, PCU) for potable water supplies at all four stations. The most probable cause of this color is complex organic compounds originating from humic materials and decaying aquatic plants. These high color levels are related additionally to the elevated iron concentrations discussed later in this section.

Corresponding to the low turbidity levels, total suspended solids (TSS) concentrations at stations on the North and East Forks are generally low. Based on 1977-1978 observations three of the four on-site stations averaged 7 mg/l while Station 2 averaged 12 mg/l (Table 2-I). Four percent (one of twenty-four) of the total TSS determinations at Stations 2 and 3 on the North Fork exceeded the 60 mg/l level. To obtain a more reliable estimate of the frequency with which TSS concentrations may be expected to exceed

60 mg/l, a frequency analysis based on a lognormal distribution of TSS concentrations was undertaken. The analytical method (see Appendix A for details) was developed by Larsen (1971) of EPA for relating air quality measurements to air quality standards. Because the TSS data exhibit an apparent lognormal distribution as air quality data generally do, the methodology is applicable to this analysis. The analysis predicted that 94 percent of all TSS determinations may fall below the 60 mg/l level, and conversely, 6 percent may be above 60 mg/l. In other words, the maximum daily effluent limitation applicable to phosphate rock mining and beneficiation facilities (40 CFR 136) may be exceeded on the average of 22 days each year in the undisturbed stream.

The analysis also predicted that the 30-day average effluent limitation of 30 mg/l (40 CFR 136) may be expected to be exceeded 17 percent of the time. In fact, 12.5 percent of the measured concentrations (3 of 24) exceeded 30 mg/l.

A similar frequency analysis was performed with TSS data from Stations 1 and 4 on the East Fork. The 60 mg/l level was not exceeded by any of the 28 measurements at these sites. However, the analysis predicted that 60 mg/l may be exceeded 0.07 percent of the time or about once every four years. The 30 mg/l level was exceeded by one measurement (3.6 percent of the total) while the frequency analysis predicted that on the average TSS levels in excess of 30 mg/l may be expected 1.4 percent of the time.

Generally, the foregoing analysis supports the observation that elevated TSS levels comparable in magnitude to federal effluent limitations applicable to phosphate mining operations occur with some frequency in surface waters on the proposed site.

Average suspended solids concentrations at Stations 9 and 10 downstream of the site were nearly twice as high as the overall average TSS at on-site stations (15 mg/l compared to 8 mg/l). This difference is most likely attributable to the greater algae biomass in the unshaded and, hence, more productive waters.

Major Cations and Anions - Water in the North and East Forks is low in dissolved solids and characteristically soft as evidenced by the average total hardness range of 41 to 65 mg/l at on-site stations (Table 2-I). Alkalinity (as $CaCO_3$) ranged from 7 to 124 mg/l in streams on the site, and many of the measurements were below the 20 mg/l minimum standard for Florida's Class I-A and Class III waters. Variations with the standard occurred more frequently in the North Fork where 8 of 20 determinations were below the standard while in the East Fork only 2 of 24 were below it. The U.S. EPA does not place an absolute lower limit on alkalinity, recognizing that alkalinity levels below 20 mg/l may occur naturally in certain waters (EPA, 1976). Because of its importance in buffering pH change, EPA recommends that alkalinity not be further reduced in waters whose natural alkalinity is below 20 mg/l.

Average pH values of Station 1 through 4 ranged from 6.3 to 6.6 with a minimum pH of 5.5 measured at Station 2 and a maximum of 7.1 at both Stations 2 and 3 on the North Fork. Values of pH below the State's minimum standard for Class III waters (6.0) were measured at Station 2 where 3 of the 11 pH determinations were below 6.0. In spite of these variations, the observed pH values appear to reflect natural conditions in the East Fork. Table 4.2-A summarizes pH data from adjacent river segments as well as the Manatee River. The average and extreme values of

Table 4.2-A Selected pH Data for Adjacent Watersheds.

River Segment	Designation in Table 2-H	pH Min.	 Max.	 Avg.
Horse Creek	HC1	6.4	8.6	7.4
	HC2	5.7	7.5	6.5
	HC3	5.9	8.5	7.2
Myakka River	MY1	5.5	7.2	6.5
Little Manatee R.	LM1	6.5	7.1	6.8
	LM2	6.7	7.4	7.2
Manatee River	M1	5.5	7.7	6.5
	M2	5.5	8.0	6.7
Peace River	P9	4.2	8.9	7.3
	P10	6.7	8.0	7.3

Source: Central Florida Phosphate Industry Areawide Impact Assessment Program, EPA, 1978.

pH observed in the upper Manatee River (LM1) are comparable to those in adjacent watersheds.

Average concentrations of the major anions — chloride and sulfate — are low compared to the State's drinking water standard although sulfate exhibits noticeable variability. Standard deviations of sulfate at Stations 2 and 3 on the North Fork Manatee River exceed the means by 29 and 100 percent, respectively (Table 4.2-B). Nevertheless, the maximum observed concentrations of chloride (28 mg/l at Station 1) and sulfate (42 mg/l at Station 1) are well below the allowable level of 250 mg/l for water supplies.

The mean fluoride concentrations at Stations 1 through 4 (0.31 to 0.43 mg/l) are typical of levels found in undisturbed streams in west central Florida (Table 2-H), but are above the levels found in uncontaminated streams in other areas of Florida (Ardaman and Associates, Inc., 1978). Dissolution of the phosphate-bearing mineral, fluorapatite ($Ca_5(PO_4)_3F$) is considered the major source of fluoride. Neither the State Class I-A (Potable Water Supplies) nor NIPDWR standards for fluoride (1.5 and 1.4 mg/l, respectively) was exceeded by any of the measured concentrations. However, the fluoride standard of 0.8 mg/l in F.A.C., Chapter 17-22 (Water Supplies) was slightly exceeded by one of eleven measurements at Station 2 on the North Fork where 0.82 mg/l was observed. At Stations 9 and 10 downstream of the site the frequency of variation with the standard was significantly greater. For example, annual average fluoride concentrations at Station 9 in 1974 and 1976 were 0.82 and 0.84, respectively. In the Lake Manatee reservoir (Station 10), two of the ten fluoride determinations exceeded 0.8 mg/l, and a maximum of 1.05 mg/l was measured. In spite of these occasional variations in fluoride levels with the State's finished drinking water

Table 4.2-B Statistical Summary of Water Quality Parameters Stations 1 through 4 (1977-1978).

	Station 1				Station 2				Station 3				Station 4			
Parameter	$\bar{x}$	S.D.	Minimum	Maximum	$\bar{x}$	S.D.	Minimum	Maximum	$\bar{x}$	S.D.	Minimum	Maximum	$\bar{x}$	S.D.	Minimum	Maximum
DISCHARGE, cfs	28	36	1.1	110	37	59	0.9	105	28	41	0.5	132	36	42	2.2	122
DISSOLVED OXYGEN, mg/l	5.2	1.3	3.4	7.8	4.7	1.8	2.3	7.5	5.2	1.7	3.5	8.2	5.1	2.1	4.2	8.5
CONDUCTIVITY, µmho/cm	157	59	74	260	94	35	48	156	152	173	52	660	134	46	66	230
pH (median)	6.6	--	6.0	6.8	6.3	--	5.5	7.1	6.5	--	6.0	7.1	6.6	--	6.4	6.9
MAJOR CONSTITUENTS AND RELATED [illegible], mg/l																
CALCIUM, as Ca	17.6	7.8	5.6	32.5	17.1	13.2	4.8	49.7	11.0	5.3	4.3	23.2	13.6	5.0	5.3	24.0
IRON, as Fe	1.2	1.2	0.0	4.2	1.7	1.2	0.2	3.6	1.7	2.2	0.1	7.6	1.6	2.3	0.0	8.4
MAGNESIUM, as Mg	5.1	2.3	2.3	11.5	3.4	1.6	0.8	5.3	3.4	2.4	1.2	10.3	4.5	2.0	1.7	9.6
SODIUM, as Na	8.2	2.2	4.1	10.8	7.8	1.8	5.0	9.5	6.1	1.2	4.8	8.6	7.6	2.0	5.2	12.4
SULFATE, as SO_4	19	11	0	42	7	9	0	26	4	8	0	25	12	8	0	30
CHLORIDE, as Cl	20	5	12	28	17	3	10	21	14	3	9	22	17	4	10	24
FLUORIDE, as F	0.41	0.12	0.27	0.66	0.43	0.18	0.26	0.82	0.31	0.09	0.18	0.44	0.37	0.12	0.21	0.56
ALKALINITY, as $CaCO_3$ Total	38	13	16	62	21	15	7	55	36	33	10	124	45	28	17	110
TDS at 105°C	151	39	94	231	135	40	69	192	121	48	71	242	126	29	69	189
MACRONUTRIENTS AND RELATED CONSTITUENTS, mg/l*																
NITROGEN, as N																
Total	0.96	1.05	0.23	4.21	0.72	0.18	0.38	0.94	0.66	0.13	0.48	0.82	1.24	1.35	0.34	4.77
Ammonia	0.30	0.16	0.08	0.60	0.35	0.11	0.22	0.50	0.24	0.14	0.08	0.58	0.28	0.16	0.07	0.56
Nitrate	0.15	0.11	0.00	0.45	0.16	0.07	0.00	0.24	0.13	0.08	0.00	0.28	0.14	0.07	0.00	0.26
PHOSPHATE, as P																
Total	0.43	0.14	0.24	0.76	0.50	0.18	0.28	0.86	0.50	0.26	0.24	1.07	0.43	0.15	0.24	0.77
Ortho	0.33	0.09	0.19	0.47	0.40	0.11	0.23	0.54	0.31	0.14	0.09	0.56	0.35	0.13	0.20	0.68
SILICA, as SiO_2	7.5	3.2	3.4	16.1	11.4	4.8	4.7	19.7	9.3	3.3	4.0	15.1	7.3	3.0	2.7	13.1
TURBIDITY, NTU	1.8	0.7	1.0	4.0	1.3	0.6	0.6	2.5	1.9	0.7	1.0	3.1	1.5	0.3	1.0	1.9
COLOR, PCU	122	75	20	250	230	92	100	360	153	71	30	225	126	76	20	230
BOD (5-Day)	1.4	1.1	0.3	4.0	1.2	0.8	0.3	2.9	1.2	1.1	0.3	4.0	1.0	0.7	0.4	2.2

$\bar{x}$ = Mean
S.D. = Standard Deviation
* = Unless Otherwise Noted

Reproduced from best available copy.

Source: Ardaman and Associates, 1978.

standard, fluoride levels in treated water delivered to Manatee County users have not been found to exceed 0.8 mg/l (Table 4.2-C).

Macronutrients - Average measured concentrations of total phosphorus as P at Stations 1 through 4 ranged from 0.43 to 0.50 mg/l. A peak concentration of 1.07 mg/l was observed at Station 3, and a minimum of 0.24 mg/l was noted at three of the four on-site stations (Table 2-I). The average phosphorus concentrations are considerably above the 0.070 mg/l average of river waters worldwide (Hutchinson, 1975) and the 0.050 mg/l criterion proposed by EPA (1976). Nevertheless, the observed phosphorus levels are consistent with phosphorus concentrations generally found in central Florida streams (Table 2-H). Dissolution of natural phosphate-bearing minerals and leachate and runoff from pastures and fertilized croplands are the most likely sources of phosphorus (Ardaman and Associates, Inc., 1978); however, the relative contribution from each source is not easily determined from available data. EPA (1976) recognizes a number of naturally occurring phenomena which reduce the threat of phosphorus to lake eutrophication including situations where nutrients other than phosphorus are the factors limiting plant growth.

Average total nitrogen concentration at the four on-site stations ranged from 0.66 mg/l to 1.24 mg/l. Concentrations at Stations 1 and 4 on the East Fork were 0.96 mg/l and 1.24 mg/l respectively, noticeably above the 0.72 mg/l and 0.66 mg/l average at Stations 2 and 3 on the North Fork. Inordinately high values of organic nitrogen were measured in April, 1978 at Station 1 and in August, 1977 and April, 1978 at Station 4 (Table 2-C). Corresponding to these peaks in total nitrogen were sharp increases in organic nitrogen while ammonia, nitrate, and nitrite remained relatively unchanged amongst stations on the North and East Forks.

Table 4.2-C Fluoride Concentrations in Manatee County Water Treatment and Distribution Systems.

Date of Measurement	Treatment Plant Influent*	Treatment Plant Effluent	Distribution System
October 6, 1975	.41**	.34	---
March 29, 1976	.43	.44	.44
April 25, 1977	.19	.14	.14
April 3, 1978	.30	.106	.103

* Raw water drawn from west end of Lake Manatee

** All units in milligrams per litre

Source: Manatee County Utilities Water Plant

While ordinarily prime determinants of aquatic plant growth, nitrogen and phosphorus do not limit primary productivity over most stream courses on the site. Light is the apparent factor limiting aquatic plant growth on the site due to the dense canopy of swamp forest overhanging the streams. The few areas that lack the forest canopy support dense growths of benthic macrophytes (Biology and Ecology Resource Document) and nitrogen becomes operationally significant as a limiting factor.

The ratio of nitrogen to phosphorus (by weight) in natural waters on the average is about 23:1 (Hutchinson, 1944). These two elements are assimilated by phytoplankton in a proportion of about 6.7:1 on the average (Deevey, 1970). Therefore, in aquatic systems in general phosphorus is the nutrient limiting primary productivity (Hutchinson, 1975).

Average N:P ratios at stations in the upper Manatee River basin ranged from 1.63 on the East Fork to 3.30 on the North Fork. These N:P ratios are substantially lower than the 23:1 ratio characteristic of natural waters and, more importantly, are below the 13:1 ratio) of inorganic nitrogen to orthophosphorus) which EPA (1977) uses as the threshold for nitrogen limited aquatic systems. Because nitrogen is in relatively short supply compared to phosphorus, nitrogen is potentially the nutrient which limits primary productivity in the area's water except where productivity is limited by other factors (e.g., light).

The average N:P ratio at the head of Lake Manatee is comparable to those in tributary streams on the Duette Mine site indicating that nitrogen is the apparent limiting factor. The rate of eutrophication in Lake

Manatee is expected to be more sensitive to changes in nitrogen loading than to phosphorus loading.

Metals - None of the baseline data on metals exceed the National Interim Primary Drinking Water Regulations criteria. However, several measured concentrations of copper, lead, and zinc exceeded the State's Class I-A (Potable Water Supplies) and Class III (Recreation - Propagation and Management of Fish Wildlife) standards.

Specifically, in May, June, and July of 1977, Florida's Class I-A and Class III standard of 0.03 mg/l for copper was exceeded at Stations 1 through 4 where concentrations ranged from 0.2 to 1.2 mg/l (Table 2-C). In the eight ensuing months copper concentrations at these four stations were below the limits of detectability of the analytical methods used (usually 0.1 mg/l). A more sensitive technique applied to the April, 1978 samples demonstrated that the concentrations were at that time below the 0.03 mg/l allowable limit. Ardaman and Associates, Inc.'s April, 1974 data (Table 2-C) also showed the 0.03 limit was exceeded at five of six on-site stations; but, in September of 1974, concentrations were again below 0.03 mg/l. Finally, scattered determinations of copper levels by FDER (Table 2-E) and U.S.G.S. (Table 2-F) indicated downstream concentrations at or below the 0.03 mg/l standard. Collectively, the on-site data suggest a problem with analytical procedure and/or that natural copper concentrations may occasionally exceed the State's standard in the upper reaches of the drainage basin.

Copper levels in the reservoir (Station 10, Table 2-D) have consistently been found within the limits of the FDER standard.

Average iron concentrations at Stations 1 through 4 (Table 2-I) ranged from 1.2 to 1.7 mg/l — well above the recommended level of 0.30 mg/l for potable water supplies. The Florida Department of Environmental Regulation (Table 2-E) reported average iron concentrations in the upper Manatee River Basin of 0.2 mg/l on February 21, 1978; but more complete U.S.G.S. data (Table 2-F) suggest that iron concentrations in excess of drinking water criteria occur naturally in these waters.

Ardaman and Associates, Inc. (1975) reported an average zinc concentration of 0.30 mg/l in streams on the proposed site with a maximum of 2.10 mg/l observed in the East Fork Manatee River (Station 4) in September, 1974. In that same month they measured a concentration of 0.01 mg/l at Station 9 and at Station 10 (Lake Manatee) suggesting the possibility of some inconsistency in the upstream data. If available upstream measurements are accurate, average on-site concentration is a factor of ten greater than Florida's Class I-A zinc standard of 0.03 mg/l. However, the maximum measured concentration (2.1 mg/l) is below the 5.0 mg/l criterion recommended by EPA for domestic water supplies. In contrast to the 1974 results, FDER (Table 2-E) and U.S.G.S. (Table 2-F) have recently reported zinc concentrations at Stations 1, 2, and 9 to be at or well below the State's 0.03 mg/l criterion.

Of a total of nineteen determinations of lead concentration at or downstream of the proposed site, two exceeded Florida's lead standard for potable water supplies (0.03 mg/l). The U.S.G.S. measured a lead concentration of 0.039 mg/l in May, 1977 at Station 9 (Table 2-F). The five lead measurements at Station 9 reported in the data base average 0.019 mg/l indicating that an elevated lead level at this station is not a chronic condition. A second deviation from the State's standard was observed in April, 1974 at Station 4 where 0.438 mg/l was measured (Table 2-C), but this was reportedly due to sample contamination. Of the several recognized paths of lead entry into aquatic environments, entrainment of deposits from automotive exhaust in stormwater runoff is the most likely cause of occasional peaks in lead concentration in the subject streams.

Toxins/Bacteriological - The concentrations of total ammonia at which the un-ionized fraction exceeds the State's standard of 0.02 mg/l are tabulated in Table 4.2-D as a function of pH and temperature. None of the fifty separate determinations of total ammonia at the North and East Fork monitoring stations have corresponding un-ionized ammonia concentrations in excess of the 0.02 mg/l standard.

The limited available data on phenol levels in the area's surface waters indicates the State's standard of 1.0 microgram per liter (μg/l) was exceeded at the four on-site stations and at Stations 9 and 10 downstream (Table 2-C). The East Fork stations averaged 13.6 μg/l and the North Fork 10.9 μg/l while Stations 9 and 10 averaged 4.2 μg/l. A maximum on 14.9 μg/l was observed at Station 1. Several agriculturally-related sources of phenols have been identified in previous studies (EPA, 1976), and may be contributing sources at the affected measurement sites. These include: livestock dips; animal wastes; and the hydrolysis, chemical oxidation, and microbial degradation of pesticides.

Total coliform bacteria levels at all on-site and downstream stations consistently exceeded Florida Class I-A standard of 1000 coliform/100 ml of sample. However, total coliform counts may include bacteria of

Table 4.2-D Concentrations of Total Ammonia (NH_3 + NH_4^-) Which Contain an Un-ionized Ammonia Concentration of 0.020 mg/l NH_3(mg/l)*

Temperature (°C)	pH Value								
	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
5	160.	51.	16.	5.1	1.6	0.53	0.18	0.071	0.036
10	110.	34.	11.	3.4	1.1	0.36	0.13	0.054	0.031
15	73.	23.	7.3	2.3	0.75	0.25	0.093	0.043	0.027
20	50.	16.	5.1	1.6	0.52	0.18	0.070	0.036	0.025
25	35.	11.	3.5	1.1	0.37	0.13	0.055	0.031	0.024
30	25.	7.9	2.5	0.81	0.27	0.099	0.045	0.028	0.022

*[Abstracted from Thurston et al. (1974)]

vegetative and soil origins, and other organisms of uncertain taxonomy whose sanitary significance is questionable (EPA, 1973). Fecal coliform, on the other hand, is a more specific indicator of warm-blooded animal feces contamination. Only one measurement of fecal coliform at the four on-site stations (2000/100 ml at Station 3, Table 2-C) varied with the State standard of 200/100 ml. While overflow and seepage from septic tanks is a possible source of fecal contamination (TBRPC, 1978), the most probable cause of elevated bacteria levels is runoff and seepage of waters contaminated by livestock wastes.

4.3 South Fork Little Manatee River

The assessment of existing water quality in the South Fork Little Manatee River is based on data from three sampling locations — Station 5 and 6 on the Duette mine site and Station 7 about two miles downstream of the site. The results of Ardaman and Associates, Inc. (1975) hydrologic studies on the proposed site constitute the baseline data at Stations 5 and 6 (Table 2-C). That study investigated a large number of parameters, but at only two points in time (April and September, 1974). A smaller group of particularly important parameters has been monitored monthly at Station 7 (Conservation Consultants, Inc., 1977) since October, 1976 (Table 2-G), which along with quarterly data reports from U.S.G.S. (Table 2-F) provides the baseline for Station 7.

The following discussion focuses on variations in measured water quality with State and Federal standards. Unless otherwise noted the probable causes of these variations are the same as described in the foregoing Section 4.2.

Physical water quality parameters in the South Fork Little Manatee River exhibit similar patterns to those in the North and East Forks Manatee River. Stream discharge rates are highly variable; however, the peak discharge is only a small fraction of discharge rates in North and East Forks. For example, in water year 1977, U.S.G.S. reported a peak discharge of 2.16 cfs at Station 7 (U.S.G.S., 1978) compared to Ardaman and Associates, Inc.'s (1978) measurements of 262 cfs in the East Fork and 307 cfs in the North Fork in the same year (Tables 4.2-D through 4.3-D). The water is, furthermore, highly colored and consistently exceeded the State standard of 75 PCU at Stations 5, 6, and 7. Also, like the North and East Forks, dissolved oxygen concentrations were below the 5.0 mg/l standard more often than not (Table 4.1-B).

Only two measurements of total suspended solids (TSS) concentrations at each of Stations 5 and 6 on the proposed mine site are available in the data base (Table 2-C). Three of these four measurements exceeded the 30 mg/l 30-day average effluent limitation of 40 CFR 136, and one exceeded the 60 mg/l daily maximum limitation. In contrast to these high levels, data at Station 7 (2.1 miles downstream of Station 6) shows a maximum TSS concentration of 21 mg/l in twenty-six separate measurements (Table 2-G). While the data at Stations 5 and 6 are insufficient to reliably estimate the frequency at which effluent limitations are likely to be exceeded in the long term, they adequately demonstrate that such variations do occur in the segment of the stream on the site.

With the exception of pH none of the major cations and anions, including fluoride and alkalinity, varied with the standards. Average pH at Station 5 and 6 on the Little Manatee River was slightly above the 6.5

Table 4.3-A 1977 Summary of Average Daily Stream Discharge Station 1, East Fork Manatee River.

Month	Days of Record	Total (cfs)	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	cfs/mi² (12.6 mi²)	Volume (cf·10⁶)
January	9	>71	7.9	22	3.5	0.62	>6.1
February	28	139	5.0	16	2.0	0.40	12
March	31	86	2.8	7.4	1.1	0.22	7.5
April	30	25	0.84	1.3	0.28	0.07	2.2
May	31	48	1.6	9.8	0.25	0.12	4.2
June	25	>46	1.9	7.0	0.51	0.15	>4.0
July	31	262	8.4	39	0.76	0.67	23
August	28	>747	26.7	95	2.5	2.1	>65
September	24	>1516	63.2	147	11	5.0	>131
October	30	>437	14.6	57	4.9	1.2	>38
November	29	>165	5.7	15	2.1	0.45	>14
December	30	>1530	51.0	262	5.5	4.0	>132
Yearly Summary	326	>5072	15.6	262	0.25	1.2	>439

Source: Ardaman and Associates, Inc., 1978

Table 4.3-B 1977 Summary of Average Daily Stream Discharge Station 2, North Fork Manatee River.

Month	Days of Record	Total (cfs)	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	cfs/mi² (5.2 mi²)	Volume (cf·10⁶)
January	28	>272	9.7	18	6.9	1.9	>24
February	25	>290	11.6	31	6.3	2.2	>25
March	30	178	5.9	14	<0.10	1.1	15
April	30	<3.0	0.1	<0.10	<0.10	0.02	<0.26
May	30	<3.0	0.1	<0.10	<0.10	0.02	<0.26
June	27	>67	2.5	7.2	<0.10	0.48	5.8
July	10	>131	13.1	67	3.2	2.5	>11
August	24	>124	5.2	12	0.25	1.0	>11
September	26	>874	33.6	87	3.3	6.5	>76
October	24	>278	11.6	39	2.0	2.2	>24
November	25	>203	8.1	18	2.9	1.6	>18
December	26	>816	31.4	100	8.7	6.0	>71
Yearly Summary	305	>3239	10.6	100	<0.10	2.0	>280

Source: Ardaman and Associates, Inc., 1978

Table 4.3-C 1977 Summary of Average Daily Stream Discharge Station 3, North Fork Manatee River.

Month	Days of Record	Total (cfs)	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	cfs/mi^2 (14.3 mi^2)	Volume (cf·10^6)
January	6	>55	11.0	20	≈0	0.77	> 4.8
February	28	99	3.5	27	≈0	0.25	8.6
March	31	64	2.1	4.4	0.80	0.14	5.6
April	30	8.4	0.28	0.80	≈0	0.02	0.73
May	30	11	0.35	14	≈0	0.02	0.92
June	30	86	2.9	17	0.66	0.20	7.4
July	24	>303	12.6	88	0.90	0.88	>26
August	28	>674	24.1	153	1.9	1.7	>58
September	29	>2177	75.1	292	2.6	5.3	>188
October	30	>345	11.5	99	1.4	0.80	>30
November	27	>195	7.2	50	1.3	0.51	>17
December	31	1086	35.0	307	4.0	2.5	>94
Yearly Summary	324	>5103	15.8	307	≈0	1.1	>441

Source: Ardaman and Associates, Inc., 1978

Table 4.3-D 1977 Summary of Average Daily Stream Discharge Station 4, East Fork Manatee River.

Month	Days of Record	Total (cfs)	Mean (cfs)	Maximum (cfs)	Minimum (cfs)	cfs/mi² (20.0 mi²)	Volume (cf·10⁶)
January	29	>351	12.1	27	6.2	0.61	>30
February	28	219	7.8	25	4.1	0.39	19
March	31	143	4.6	7.9	2.6	0.23	12
April	30	65	2.2	2.9	1.5	0.11	5.6
May	27	>101	3.8	27	1.2	0.19	>8.7
June	10	>54	5.4	20	1.7	0.27	>4.6
July	11	>234	21.3	44	5.4	1.1	>20
August	23	>726	31.6	124	5.0	1.6	>63
September	29	>2261	78.0	241	14	3.9	>195
October	30	>455	15.2	52	5.8	0.76	>39
November	27	>251	9.3	38	4.2	0.46	>22
December	22	>1020	46.4	119	8.0	2.3	>88
Yearly Summary	297	>5880	19.8	241	1.2	1.0	>507

Source: Ardaman and Associates, Inc., 1978

minimum recommended by EPA. An average pH of 6.2 was observed at Station 7 downstream of the site where the stream's minimum pH of 5.7 was also recorded.

Variations in metal concentrations with water quality standards followed the same pattern as observed in the upper Manatee River basin where occasional variations with copper, iron, and zinc standards were measured. The State's copper standard of 0.02 mg/l was exceeded at Stations 5 and 6 where concentrations of 0.07 and 0.04 mg/l, respectively, were measured (Table 2-C). A single variation with the State's iron standard (0.3 mg/l) was observed at Station 5 where a maximum iron concentration of 0.34 mg/l was recorded. Finally, one variation with the State's zinc standard (0.03 mg/l) was observed at Station 6 where a peak concentration of 0.09 mg/l was measured. The magnitude of variations with the iron and zinc standards are considerably less than noted in the Manatee River basin, although the data base is also considerably smaller.

The description of current nutrient levels is based on Station 7 data (Table 2-G) which is much more complete than data from either Stations 5 or 6 on the site (Table 2-C). The average total nitrogen concentration at Station 7 (1.05 mg/l) agrees well with the values observed in the Manatee River basin. Furthermore, the occasional spikes in nitrogen concentration (6.15 mg/l maximum) correspond to large increases in the organic nitrogen fraction — the same relationship exhibited in the Manatee River data. Average total phosphorus concentration at Station 7 (0.68 mg/l) was above the average at the other stations. Similarly, the maximum concentration of 1.60 mg/l is the largest of any in the data base.

Relatively little data exist on coliform bacteria content of the South Fork Little Manatee River. All determinations of total coliform vary with the State's standard; but only one of the fecal coliform determinations (1000/100 ml at Station 6) exceeds the State's standard of 200/100 ml.

5. SUMMARY

5.1 Upper Manatee River Basin

The North and East Forks of the Manatee River are characterized by highly variable discharge rates which strongly influence local water quality. Occasionally large and/or consistent variations with State and/or Federal water quality standards and criteria were observed in measured concentrations of dissolved oxygen, color, pH, phosphorus, copper, iron, zinc, phenols, and coliform bacteria (total and fecal). Smaller variations with standards were noted in fluoride, ammonia, alkalinity, lead, and manganese measurements. For the most part, these variations appear to reflect natural conditions in these waters. Furthermore, the quality of the water has permitted the development and maintenance of moderately dense and diverse faunal communities in the streams. Two pertinent conclusions of this study's ecological investigations are summarized below:

- The characteristics of the periphyton community (e.g. dominance, density, species richness, etc.) appear to reflect the natural state of the stream's detrital based ecosystem.

- Benthic macroinvertebrate communities at the study sites are characteristic of "clean" water conditions and detrital based system.

5.2 South Fork Little Manatee River

The South Fork of the Little Manatee River is characterized by an equally variable but much lower average discharge rate than either the North or East Fork of the Manatee River. Dissolved oxygen, pH, phosphorus, copper, phenols, and total coliform bacteria concentrations may vary frequently with State and Federal standards. Less frequent variations are exhibited by iron, zinc, and fecal coliform levels. On the basis of analyses of periphyton and macroinvertebrate community structures, the Little Manatee River (South Fork) and Manatee River (North and East Forks) are noticeably dissimilar (Biology and Ecology Resource Document). Nevertheless, both systems are characterized by "clean" water conditions and detrital based systems.

PART II

SURFACE WATER QUALITY IMPACT

SURFACE WATER QUALITY IMPACT
RESOURCE DOCUMENT

LIST OF TABLES

		Page
Table 2-A	Silver City Mine Effluent Composition, August 16, 1978, Grab Sample	70
Table 2-B	Water Discharge - Swift Agricultural Chemicals Corporation Silver City Mine - Monthly Summary Settling Area No. 8, Spillway No. 5 - FDER Permit I053-2352, NPDES Permit FL 0001171	73
Table 2-C	Plant Recirculation System Nitrogen Balance	75
Table 3-A	NPDES Permit Application Effluent Limitations	77
Table 4.2-A	Stream Concentrations and Mass Loadings	85
Table 4.2-B	Effluent Concentrations and Mass Loadings (Average daily for months of discharge)	86
Table 4.2-C	Combined Mass Loadings and Resultant Concentrations	90
Table 4.2-D	Existing Stream Loadings	91
Table 4.2-E	East Fork Manatee River Mass Loadings and Concentrations after Mixing	92
Table 4.2-F	North Fork Manatee River Mass Loadings and Concentrations after Mixing	93
Table 5.2-A	Summary of Hydrologic Impact	105
Table 5.3-A	Short-term Water Quality Impact	114

SURFACE WATER QUALITY IMPACT
RESOURCE DOCUMENT

LIST OF FIGURES

Page

Figure 1-1 Swift Duette Mine discharge points and water quality monitoring stations.................67

Figure 1-2 Schematic of water flow...........................68

Figure 4.2-1 Average Monthly Flows, Duette Mine................84

Figure 4.2-2 Peak Flood Discharge.............................88

Figure 4.3-1 Surface Water Sampling Stations..................97

Figure 5.2-1 Calculated Final Waste Clay Distrbution along Manatee River due to Hypothetical Failure of Settling Area (Waste clay initially at 18.2 percent solids).................................106

Figure 5.2-2 Calculated Final Waste Clay Distribution along Manatee River due to Hypothetical Failure of Settling Area (Waste clay initially at 23.6 percent solids) 108

Figure 5.2-3 Mass Volume vs. Time for Lake Manatee 109

PART II - SURFACE WATER QUALITY IMPACT

1. DESCRIPTION OF PLANT WATER SYSTEM

This impact assessment considers the effects of treated wastewater discharges from the water recirculation system of the proposed mining and beneficiation facility on streams leaving the site. The major features of the water recirculation system and their locations on the site are shown in Figure 1-1. Points of discharge to surface waters on the site are also indicated. The routes by which water enters and leaves the mining and beneficiation process are depicted in Figure 1-2 taken from the NPDES permit application for the facility (Appendix B). The flow rates accompanying the various pathways are annual average values. Fluctuations in these rates may occur due to changes in matrix composition in different areas of the ore body, increase or decreases in production rates, variations in rainfall, and changes in seasonal evaporation and seepage rates.

The general uses of water at the facility are for ore transportation, washing, preparation of feed, flotation, and waste disposal operations. The majority of these needs is met by water from the recirculation system which supplies 142.3 million gallon per day (mgd) or 89.8 percent of the average total water requirement of the beneficiation process. Groundwater (10.08 mgd) is the major source of make-up water to the process while rainfall/runoff and the reservoir supply an additional 8.91 mgd. The quality, as well as the quantity of these makeup waters is an important determinant of the ultimate quality of the system's discharge.

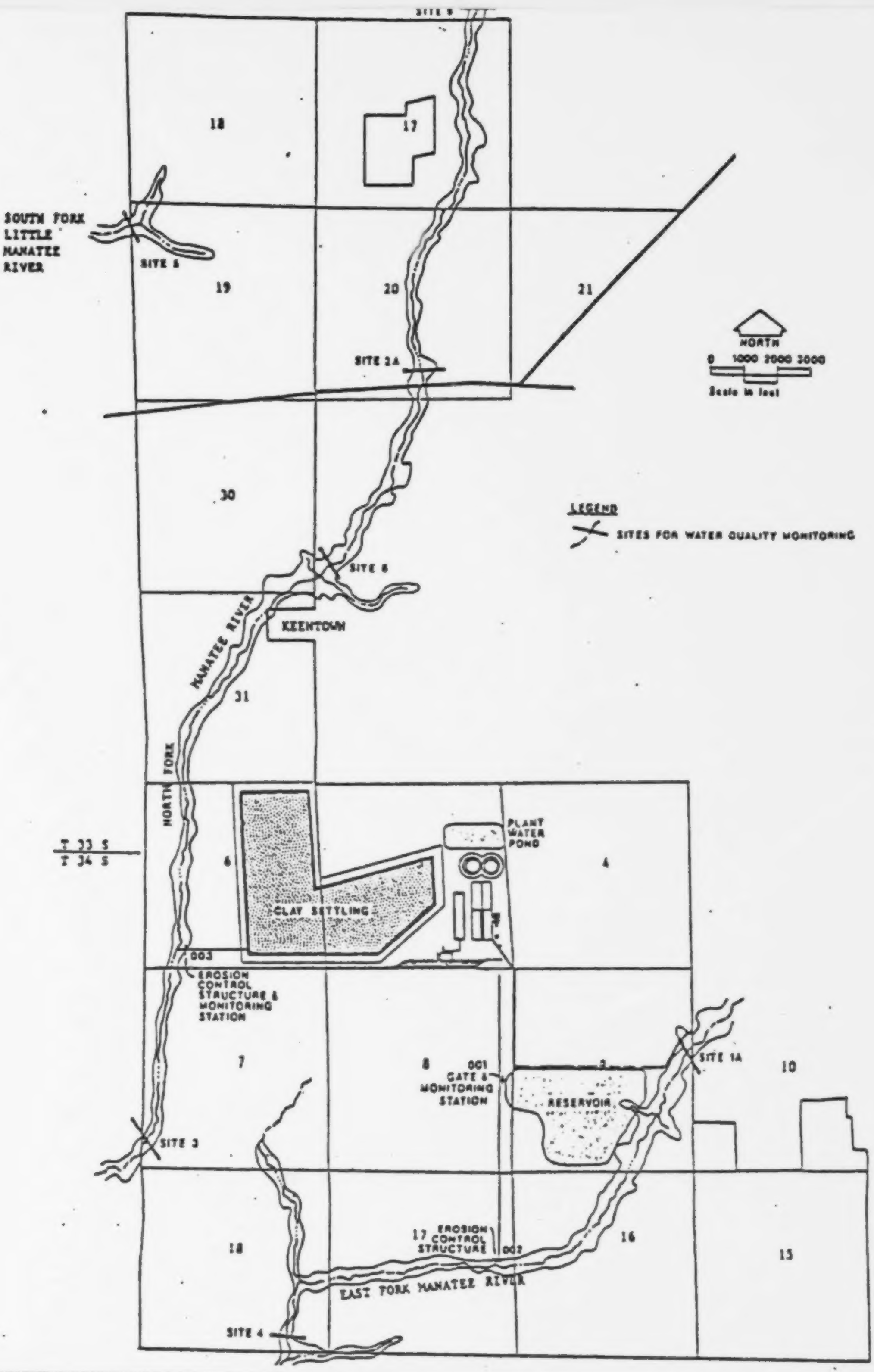

SITE 9
18
17
SOUTH FORK LITTLE MANATEE RIVER
SITE 5
19
20
21
NORTH
0 1000 2000 3000
Scale in feet
SITE 2A
30
LEGEND
SITES FOR WATER QUALITY MONITORING
SITE 8
KEENTOWN
MANATEE RIVER
31
NORTH FORK
T 33 S
T 34 S
6
CLAY SETTLING
PLANT WATER POND
4
003
EROSION CONTROL STRUCTURE & MONITORING STATION
7
8
001 GATE & MONITORING STATION
RESERVOIR
SITE 1A
10
SITE 3
18
17 EROSION CONTROL STRUCTURE
002
16
15
EAST FORK MANATEE RIVER
SITE 4

FIGURE 1-1

DISCHARGE POINTS AND WATER QUALITY MONITORING STATIONS

URCE : ZELLARS - WILLIAMS , INC. 67

U.S. EPA - REGION IV
DRAFT ENVIRONMENTAL
IMPACT STATEMENT FOR
SWIFT AGRICULTURAL CHEMICALS
CORPORATION
PROPOSED DUETTE MINE
MANATEE COUNTY , FLORIDA

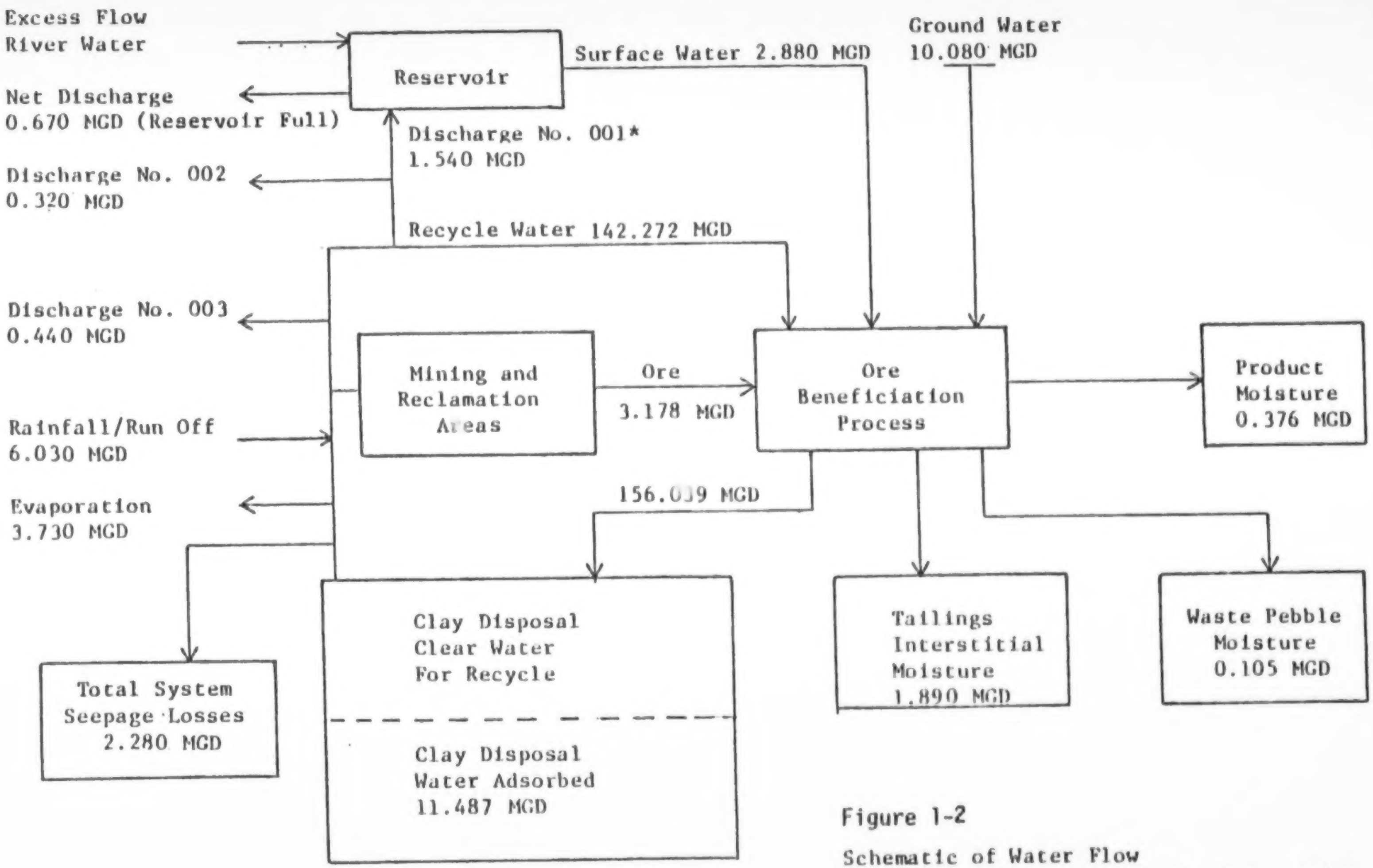

Excess Flow
River Water
Reservoir
Net Discharge
0.670 MGD (Reservoir Full)
Surface Water 2.880 MGD
Ground Water
10.080 MGD
Discharge No. 001*
1.540 MGD
Discharge No. 002
0.320 MGD
Recycle Water 142.272 MGD
Discharge No. 003
0.440 MGD
Mining and
Reclamation
Areas
Ore
3.178 MGD
Ore
Beneficiation
Process
Product
Moisture
0.376 MGD
Rainfall/Run Off
6.030 MGD
Evaporation
3.730 MGD
156.039 MGD
Total System
Seepage Losses
2.280 MGD
Clay Disposal
Clear Water
For Recycle
Clay Disposal
Water Adsorbed
11.487 MGD
Tailings
Interstitial
Moisture
1.890 MGD
Waste Pebble
Moisture
0.105 MGD

Figure 1-2

Schematic of Water Flow
Swift Agricultural Chemicals Corporation
Manatee County, Florida
July 12, 1979
Page 1 of 1
by Zellars-Williams, Inc.

* Discharge 001 is into the reservoir.

2. COMPOSITION OF DISCHARGE FROM DUETTE MINE

Portions of two streams leaving the site — the North Fork and East Fork of the Manatee River — will be affected by direct discharges from the recirculation system. Discharges are necessary at certain times of the year due to considerable temporal variation in the region's rainfall distribution. (Swift Agricultural Chemicals Corp., 1978). For 59 days during August and September of an average rainfall year, 1.959 million gallons per day (mgd) will be discharged into the East Fork (Point 002) from the mining, reclamation, and plant site areas in the southeast portion of the property, provided the water is of acceptable quality. If the quality is not acceptable, the water will be routed into the clay settling area for clarification. Effluent will be discharged for 90 days during August, September, and October of the average rainfall year to the North Fork from the clay settling area through Point 003 at a rate of 1.773 mgd.

In higher-than-average rainfall years, discharges from 002 and 003 will be greater than indicated above to maximize water use efficiency. A peak discharge rate of 72 mgd from each point is predicted to occur during the 25-year storm event (Conservation Consultants, Inc., 1979) consisting of approximately 7.7 inches of rain over a 24-hour period.

Under normal conditions the composition of effluents from both discharge points will be essentially the same as effluent from Swift Agricultural Chemicals Corporation's Silver City Mine (Tables 2-A and 2-B). However, since Swift does not intend to use ammonia (or its compounds) under normal circumstances in any processes associated with the Duette Mine (Swift Agricultural Chemicals Corp., 1979), ammonia and total nitrogen

Table 2-A Silver City Mine Effluent Composition, August 16, 1978 Grab Sample

Parameter	Result[1]	Parameter	Result[1]
Alkalinity, Total as $CaCO_3$ (Minimum)	75	Chromium (Total)	< 0.01
Alkalinity, Phenolphthalein		Copper	0.01
Aluminum	< 0.01	Cyanide (Total)	< 0.01
Ammonia (un-ionized)	0.11	Detergents (Surfactants)	< 0.01
Antimony	< 0.04	Dissolved Oxygen (minimum)	5.1
Arsenic	< 0.01	Dissolved Solids	619
Bacteriological (Total Coliform, MFT)	< 1	Fluorides	3.1
Barium	< 0.5	Hydrogen Sulfide	0.2
Beryllium	< 0.02	Iron	0.2
BOD_5	2.9	Lead	< 0.01
Boron	0.08	Manganese	< 0.3
Bromide	< 0.1	Mercury[4], μg/l[2]	< 0.2
Cadmium	<10μg/l[2]	Nickel	< 0.5
Chloride	37	Nitrogen, Ammonia - N (Total)	5.1
Chlorine	< 0.1	Nitrogen, Kjeldahl - N	7.33
		Nitrogen, Nitrate - N	0.14

Table 2-A (Continued)

Parameter	Result[1]
Nitrogen, Nitrite - N	0.11
Nitrogen, Total - N	7.57
Odor (Threshold)	0
Oils and Grease	0.0
Pesticides/Herbicides Scan	
Aldrin + Dieldrin	< 1 μg/l
Chlordane	< 1 μg/l
2, 4 - D	< 0.01
2, 4, 5 TP	< 1 μg/l
DDT	< 1 μg/l
Demeton	< 1 μg/l
Endosulfan	< 1 μg/l
Endrin	< 1 μg/l
Guthion	< 1 μg/l
Heptachlor	< 1 μg/l
Heptachlor Epoxide	< 1 μg/l
Lindane	< 1 μg/l
Malathion	< 1 μg/l
Methoxychlor	< 1 μg/l
Mirex	< 1 μg/l
Parathion	< 1 μg/l
Toxaphene	< 1 μg/l
pH	7.6
Phenols	< 0.001
Phthalate Esters	< 0.001
Phosphate, Ortho as PO_4	11.6
Phosphate, Total as PO_4	12.0
Phosphorus, Total as P	3.92
Polychlorinated biphenyls	< 1 μg/l
Radioactivity	
Gross α - activity	0.5 ± 0.5 pCi/l[3]
Radium-226	0.3 ± 0.1 pCi/l
Radium-228	< 0.1 ± 0.1 pCi/l
Uranium	< 0.01
Selenium	< 0.002
Silver	< 20 μg/l
Specific Conductance, μmhos/cm	1000
Total Suspended Solids	2

Table 2-A (Continued)

Parameter	Result
Trihalomethanes	
Chloroform	9.1 μg/l
Bromodichloromethane	0.06 μg/l
Chlorodibromomethane	< 0.10 μg/l
Bromoform	< 0.3 μg/l
Total Trihalomethanes	9.56 μg/l
Turbidity	4.8 NTU
Zinc	< 0.01

---

[1] In milligrams/liter unless otherwise noted.

[2] μg/l = micrograms per liter

[3] pCi/l = picoCuries/liter

[4] Retested after initial analysis showed unrealistically high concentration suggesting sample contamination.

.e 2-B Water Discharge-Swift Agricultural Chemicals Corp. Silver City Mine-Monthly Summary
Settling Area No.8, Spillway No.5-FDER Permit IO53-2352, NPDES Permit FL 0001171

Month	No.of Weeks	No.of Samples	Ave.Flow (MGD)	pH		P(Mg/1)			F(mg/1)			TSS (Mg/1)		
				Min.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.
June 1976	4	4	1.933	7.2	8.6	0.16	0.22	0.28	2.0	2.3	3.0	3.5	14.3	23.5
July 1976	4	4	2.258	7.2	8.7	0.26	0.30	0.46	2.1	2.2	2.2	9.0	18.5	33.0
Aug.1976	5	5	1.225	7.4	8.3	0.12	0.20	0.31	2.2	2.3	2.4	5.5	12.6	24.0
Sept.1976	4	2	3.011	7.2	7.6	0.35	0.40	0.40	2.5	2.5	2.5	3.5	3.6	3.8
Oct. 1976	4	4	6.859	7.3	7.8	0.32	0.39	0.46	2.7	2.8	2.8	3.0	7.2	8.5
Nov. 1976	5	4	6.735	7.3	9.0	0.56	0.78	0.89	2.6	2.7	2.6	1.5	8.0	13.0
Dec. 1976	4	1	2.022	7.3	7.3	14.7	14.7	14.7	4.9	4.9	4.9	9.0	9.0	9.0
Jan.1977	5	5	3.174	7.0	8.5	0.41	0.76	1.3	2.0	2.1	2.2	4.0	33.3	105.0
Feb.1977	4	4	1.662	7.4	8.6	0.25	0.45	0.74	2.0	2.1	2.4	5.0	7.0	11.0
Mar.1977	4	1	0.276	8.4	8.4	2.7	2.7	2.7	2.9	2.9	2.9	8.0	8.0	8.0
Apr.1977	4	0	None											
May 1977	5	0	None											
June 1977	4	1	5.5	7.3	7.3	5.1	5.1	5.1	1.3	1.3	1.3	10.0	10.0	10.0
July 1977	4	4	7.146	7.3	8.8	3.0	4.2	4.8	1.2	3.1	3.5	9.0	17.7	29.0
Aug. 1977	5	2	9.05	6.9	7.3	1.3	1.9	2.0	3.5	3.7	3.7	13.0	22.3	24.0
Sept.1977	4	3	18.417	7.1	8.4	0.64	0.70	0.82	3.6	3.9	4.0	4.5	13.1	19.5
Oct. 1977	4	1	0.16	7.5	7.5	0.42	0.42	0.42	3.6	3.6	3.6	4.0	4.0	4.0
Nov. 1977	4	1	4.859	7.1	7.1	1.0	1.0	1.0	2.9	2.9	2.9	21.0	21.0	21.0
Dec. 1977	4	0	None											
Jan. 1978	5	4	3.099	8.2	9.0	0.20	0.36	0.53	2.1	2.1	2.2	4.0	7.1	8.5
Feb. 1978	4	4	8.386	8.1	8.2	0.50	0.61	1.0	1.7	2.0	2.2	6.0	8.7	22.0
Mar.1978	4	3	2.444	7.3	9.7	0.50	0.80	1.01	1.36	1.57	1.8	7.5	15.8	22.0
Apr, 1978	4	0	None											
May 1978	5	1	0.058	6.4	6.4	1.2	1.2	1.2	2.3	2.3	2.3	7.0	7.0	7.0
June 1978	4	3	4.937	6.8	7.6	0.60	0.71	0.90	2.1	2.1	2.2	8.0	10.3	17.0
Weighted Average		61					1.15			2.5			13.3	

values in the discharge will be much less than the 5.1 and 7.6 mg/l measured in the Silver City effluent (Table 2-A).

To demonstrate this the total nitrogen concentration in the plant discharge was estimated through a mass balance computation (Table 2-C) using the best available data from the Surface Water Quality Baseline Resource Document and other qualified sources. The predicted nitrogen level in the discharge is 0.5 mg/l, less than half of the 1.1 mg/l background level in the East Fork (Part I, Table 2-I). A comparison of the relative flow rates and concentrations listed in Table 2-C reveals that the substantial groundwater and rainwater inputs with their relatively low nitrogen concentrations will dilute the higher nitrogen concentrations in the river water and sewage treatment plant effluent. Since the average nitrogen level in the East Fork exceeds that in the effluent, the net effect will be to slightly decrease the nitrogen concentration in the East Fork. Inasmuch as nitrogen functions as the limiting nutrient in Lake Manatee, the reduction in total nitrogen concentration will have a favorable downstream effect (see Section 4.3 for further discussion).

The total sulfide concentration measured in the Silver City effluent (0.2 mg/l) is not representative of the sulfide levels anticipated in the discharge from the proposed facility. The high sulfide level measured at Silver City was probably due to the hypereutrophic state of waters in the discharge canal from which the sample was collected and in which both nitrogen and phosphorus are abundant (Table 2-A). This will not be the case at the proposed facility where nitrogen levels will be below background. With regard to possible influx of sulfide to the recirculation system, no

Table 2-C Plant Recirculation System Nitrogen Balance

Source	Flow Rate (mgd)	Concentration (mg/l)	Loading (lbs/day)
Rainfall	6.06	0.034[a] 0.025[a]	2.98
Groundwater	10.1	0.40[b]	33.7
Surface Water (E.Fork)	2.21	1.1[d]	20.3
Sewage Treatment Plant	0.012	20[c]	2.00

[a] Horne, 1978

[b] Avg. conc. in "moderate" and "very high" producing zones of Floridan Aquifer. (Stations I & J, Table C-1(4) DRI)

[c] 50% removal x 40 mg/l N (Medium strength domestic sewage), Horne, 1978.

[d] Avg. of Stations 1 & 4 on East Fork

sulfide has been detected (within the limitations of the analytical methods used) in either source of makeup water to the system.

Flotation reagents are used in dilute quantities (Swift Agricultural Chemicals Corporation, 1978) to separate phosphate rock from sand particles in the flotation circuits. These reagents are selected because of their property to preferentially adhere to phosphate or sand particles and achieve separation of the two materials. All reagents have preferential affinities for clay particles; hence, the flotation feed is carefully washed to remove all possible traces of clay. Flotation circuits in new plant designs seek to minimize reagent use to levels not appreciably exceeding the quantities that adhere to the product leaving the flotation circuit. Inasmuch as waters discharged from the flotation circuit join with waters containing clays from other plant operations, e.g., washing, further opportunity is provided for residual reagent to form physiochemical attachment to clay particles. Thus the concentrations of these substances are expected to be substantially less than reflected by the dilution ratios referenced above. The chemicals used in the flotation process are fatty acids, fuel oil, sodium hydroxide, dilute sulfuric acid, straight-chain amines and kerosines. These chemicals will form relatively insoluble complexes, precipitates and/or exhibit non-refractory characteristics in the environment, i.e., chemical degradation to simple compounds or molecules.

3. COMPARISON OF DISCHARGES WITH EFFLUENT LIMITATIONS AND GUIDELINES

Of the numerous water quality parameters investigated in the impact analysis, the nine listed in Table 3-A will be regulated under conditions of the NPDES permit to be issued for the proposed mine. Expected 30-day average and daily maximum concentrations are given in Table 3-A as they

Table 3-A NPDES Permit Application Effluent Limitation

Parameter	Expected 30-day Average	Expected Daily Maximum
pH	---	6.0-9.0 (min. - max.)
Temperature (winter), °F	55	---
Temperature (summer), °F	90	---
Biochemical Oxygen Demand (5-day), mg/l	2.9	---
Total Suspended Solids, mg/l	30	60
Specific Conductance, µmhos/cm @ 25°C	---	500-1000 (min. - max.)
Copper, mg/l	0.01	---
Oil and Grease, mg/l	<5	---
Total Phosphorus as P, mg/l	3.0	9.0

appear in the NPDES permit application (Appendix B). Historical discharge data from Swift's Silver City Mine (Table 2-B), results of Silver City Mine comprehensive effluent analysis (Table 2-A), and EPA's effluent guidelines applied to other mining operations in the area were taken into account in developing the expected discharge levels from the Duette Mine.

EPA has established guidelines for allowable 30-day average and daily maximum levels of total suspended solids (TSS), and total phosphorus, and recommended limits on total fluorides of 5.0 mg/l daily average and 10.0 mg/l daily maximum. The guidelines are typical of permitted mines in the area and represent the expected concentrations of these parameters in the Duette Mine effluent. Results of long-term effluent monitoring at Swift's Silver City Mine, which is representative of the effluent from the proposed mine with regard to these parameters, suggest that EPA's guidelines for fluoride and TSS would rarely, if ever, be exceeded during the life of the mine.

To estimate how frequently the expected daily average fluoride concentration of 5.0 mg/l might be exceeded, a frequency analysis of the Silver City Mine fluoride data (Table 2-B) was performed by the method developed by Larsen (EPA, 1974). The results of the analysis indicate that the allowable 30-day average of 5 mg/l is not likely to be exceeded more than once every eighty months or roughly once every seven years. Inspection of the daily maximum measurements indicates that EPA's daily maximum guideline for fluoride (10 mg/l) would be exceeded even less frequently — about once in every 350,000 measurements.

Similarly, inspection of the TSS data (disregarding the anomalous results of January, 1977) suggests that exceedances of the 30 mg/l 30-day average and 60 mg/l daily maximum guidelines would occur very infrequently.

The expected 30-day average phosphorus concentration in the Duette Mine effluent may be expected to occasionally exceed EPA's 3 mg/l guideline. Inspection of the Silver City results indicates that the 30-day average phosphorus level exceeded 3 mg/l in 14 percent of the months reported. The daily maximum guideline of 9 mg/l was exceeded only once or at a frequency of 5 percent.

The expected 30-day minimum pH of 6.0 is in accordance with EPA's effluent limitation guideline applicable to phosphate rock froth flotation operations in general (40 CFR 436.182). None of the measured pH values in the Silver City Mine effluent were below 6.0 over the period of observation albeit ammonia was used for acid neutralizing instead of sodium hydroxide as intended for the proposed facility.

One of the 61 pH measurements at Silver City (Table 2-B) exceeded 9.0 giving a frequency of exceedance of 1.6 percent.

The expected 30-day average and/or daily maximum levels of BOD, specific conductance, oil and grease, and copper were developed primarily from the August, 1978 comprehensive analysis of the Silver City Mine effluent (Table 2-A). Inasmuch as these results were based on a single grab sample, tolerances were added to most of the measured concentrations to allow for the expected variability in effluent composition.

Swift will regularly monitor effluent water quality at the permitted points of discharge to assure compliance with NPDES permit conditions.

Florida Department of Environmental Regulation effluent limitations for phosphate rock mining and processing (F.A.C. 17-6, effective October 1, 1977) are more stringent than the federal guidelines with respect to TSS and total phosphorus; however, the limitations on pH are identical. Whereas, the State's 30-day average phosphorus limitation of 3 mg/l is the same as the federal guideline, the allowable daily maximum of 5 mg/l is approximately one-half of the limit set by EPA for the proposed mine. The latter limitation was exceeded in only two of the sixty-one separate determinations of total phosphorus in the Silver City Mine effluent.

On the basis of the Silver City results the State's 30-day average TSS limitation of 12 mg/l and daily maximum limitation of 25 mg/l may be expected to be exceeded more frequently than the federal guidelines. The effects of TSS discharges on the receiving streams in which TSS levels occasionally exceed 30 mg/l under natural conditions are discussed in the following section.

4. IMPACT ON STREAM WATER QUALITY

4.1 Comparison of Discharge Water Quality with Ambient Water Quality Standards

Constituents of the plant discharge which might potentially degrade the quality of the streams leaving the site were determined through a preliminary screening process. The approach compares the expeccted concentrations of constituents in the plant effluent with ambient State and federal water quality standards. The discharge of any constituent whose concentration in the effluent is expected to be below the ambient water quality standards cannot cause the standards to be exceeded in the receiving streams (regardless of the quantity of the discharge) and will not noticeably alter the water quality. All parameters investigated in the surface water quality baseline including physical parameters, natural ions, bacteriological characteristics, trace metals, nutrient composition, and organic substances were screened in this manner. The parameters were evaluated in relation to the following ambient water quality standards and criteria: (1) F.A.C. Chapters 17-3 and 17-22 (Water Quality Standards and Public Water Supplies, respectively); (2) U.S. EPA Quality Criteria for Water (EPA 440/9-76-023); (3) National Interim Primary Drinking Water Regulations (40 CFR 141); and (4) The Central Florida Phosphate Industry Areawide Impact Assessment Program.

Of the forty-seven parameters investigated for which standards exist, fluoride and total dissolved solids (and the related parameter, specific conductance) are the only parameters whose concentration in the effluent may be expected to exceed ambient water quality standards within the limits of detectability of standard analytical techniques and, therefore, merited further investigation.

Since fluoride and TDS are defined in terms of concentration, i.e., weight per unit volume, the concentration of either constituent resulting from the mixing of the plant effluent with the receiving streams can be predicted through routine mass balance techniques. On the other hand the value of specific conductance — an electrical property of water — resulting from stream mixing cannot be readily computed. Even though

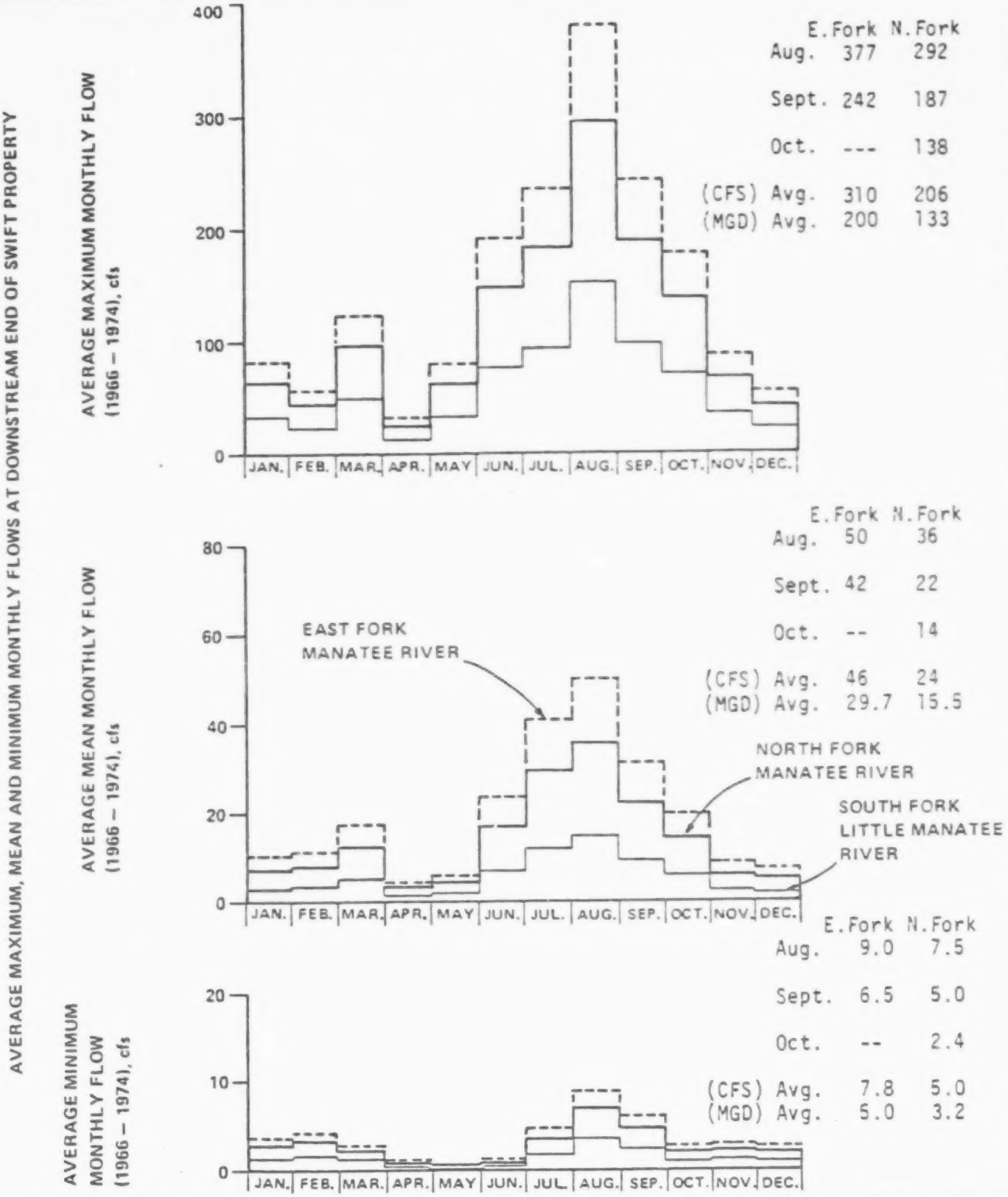
TDS and specific conductance are both dependent of the concentration of ionic matter in solution, the relationship between the two is highly variable (Horne, 1978). The ratio of TDS to specific conductance may range from 0.55 to 0.9 depending upon the quantity of undissociated organic compounds in solution (American Public Health Association, 1976) and on the relative abundance of protons, hydroxyl ions, and very large solutes (Horne, 1978). Because of the uncertainty in predicting specific conductance in mixing processes and the variability in its relationship to TDS, the latter was used in this analysis to estimate the impact of the total mineral content in the plant effluent on the receiving waters.

4.2 Predicted Mass Loadings and Concentrations

In addition to fluoride and TDS the parameters total phosphorus, total nitrogen, Biochemical Oxygen Demand (BOD), and total suspended solids (TSS) were selected for further evaluation because of their potential effects on the receiving streams or downstream potable water supplies. Total dissolved solids, fluoride, and phosphorus are discharged in concentrations somewhat above the ambient stream levels and are examined primarily in relation to their potential for degradation of the downstream uses, e.g., water supply. The 5-day BOD provides an indirect estimate of the organic carbon supply to aquatic organisms as well as indicating the demand on available stream oxygen. Total suspended solids was examined in further detail because of its close relation to phosphate mining and its regulation under state and federal effluent limitations. Nitrogen was chosen because of its potentially important role as a limiting factor of plant growth.

Each of the six parameters was evaluated by estimating mass loadings (lbs/day) and concentrations (mg/l) in both the North Fork and East Fork after complete mixing with the effluents from discharge points 003 and 002, respectively. Predictions were made for the average daily minimum and average daily maximum stream flow rates during the months of discharge (Figure 4.2-1). Average annual concentrations of parameters were used in the stream loading computations except where a parameter was reasonably well correlated with flow or the logarithm of flow ($r > 0.5$) in which case the concentration was estimated from the linear regression of concentration on flow (see Part I, Table 1-A for correlation coefficients, r). Mass loading of the above six parameters in the mine effluent were based on average discharge rates during a normal rainfall year (Tables 4.2-A and 4.2-B). Loadings of total nitrogen, BOD, and TDS were based on their expected daily average concentrations whereas loadings and resultant concentrations of total phosphorus, fluoride, and TSS were computed for both 30-day average and daily maximum contaminant levels as given in Table 4.2-B.

The combined rate of discharge from Points 002 and 003 will vary with the amount of rainfall as will the flow rates of the receiving streams. As noted previously no discharges from the water recirculation system will be made during a normal rainfall year until early August when the surface water reservoir is filled to capacity. During the following two to three months excess water will be discharged at an average rate of 1.959 mgd from point 002 and 1.773 mgd from point 003 (total of 3.73 mgd). During a lower-than-average rainfall year the discharge will be less than the combined 3.73 mgd, and during a higher-than-average rainfall year it will



	E.Fork	N.Fork
Aug.	377	292
Sept.	242	187
Oct.	---	138
(CFS) Avg.	310	206
(MGD) Avg.	200	133

	E.Fork	N.Fork
Aug.	50	36
Sept.	42	22
Oct.	--	14
(CFS) Avg.	46	24
(MGD) Avg.	29.7	15.5

	E.Fork	N.Fork
Aug.	9.0	7.5
Sept.	6.5	5.0
Oct.	--	2.4
(CFS) Avg.	7.8	5.0
(MGD) Avg.	5.0	3.2

Figure 4.2-1

AVERAGE MONTHLY FLOWS

DUETTE MINE

SWIFT AGRICULTURAL CHEMICALS CORPORATION
MANATEE COUNTY, FLORIDA

ARDAMAN AND ASSOC., INC.

Table 4.2-A Streams Concentrations and Mass Loadings

Average Minimum Flow (Adjusted for flow reduction due to mine)

	EAST FORK DISCHARGE 002			NORTH FORK DISCHARGE 003		
Parameter	Concentration (mg/l)	Flow (mgd)	Loading (lbs/day)	Concentration	Flow mg/d	Loading (lbs/day)
Total Nitrogen, as N	1.24	2.5	25.9	.66	1.4	7.7
Total Phosphorus, as P	.43	2.5	9.0	.50	1.4	5.8
Fluoride	.42	2.5	8.8	.31	1.4	3.6
BOD	1.0	2.5	20.9	1.2	1.4	14.0
TSS	7.0	2.5	146	7.0	1.4	81.7
TDS	148	2.5	3086	126	1.4	1472

Average Maximum Flow

	EAST FORK DISCHARGE 002			NORTH FORK DISCHARGE 003		
Parameter	Concentration (mg/l)	Flow (mgd)	Loading (lbs/day)	Concentration (mg/l)	Flow (mgd)	Loading (lbs/day)
Total Nitrogen, as N	1.24	195	2,077	0.66	131	721
Total Phosphorus, as P	0.43	195	699	0.50	131	546
Fluoride	0.22	195	358	0.31	131	339
BOD	1.0	195	1,626	1.2	131	1,311
TSS	7.0	195	11,380	7.0	131	7,648
TDS	77.1	195	125,400	126	131	137,700

Table 4.2-B Effluent Concentrations[a] and Mass Loading

Parameter	Concentration,(mg/l)	EAST FORK DISCHARGE 002 Flow (mgd)	EAST FORK DISCHARGE 002 Loading (lbs/day)	NORTH FORK DISCHARGE 003 Flow (mgd)	NORTH FORK DISCHARGE 003 Loading (lbs/day)
Total Nitrogen, as N	1.10[b]	1.959	18.0	1.773	16.3
Total Phosphorus, as P:					
Average	3.0	1.959	49.0	1.773	44.4
Maximum	9.0	1.959	147	1.773	133
Fluoride:					
Average	5.0	1.959	81.7	1.773	73.9
Maximum	10	1.959	163	1.773	148
BOD	2.9	1.959	47.4	1.773	42.9
TSS:					
Average	30	1.959	490	1.773	444
Maximum	60	1.959	980	1.773	887
TDS	619	1.959	10,110	1.773	9,153

[a] Unless otherwise noted concentrations are the expected 30-day average values.

[b] Based on average background level in the East Fork between Stations 1 and 4.

be more. The assumption that wastewater will be discharged at its average rate while stream flows are at their average minimum level, therefore, represents a conservative discharge condition for 'worst case' evaluation.

Plant discharges much larger than the combined 3.73 mgd will occasionally occur (e.g., 144 mgd during the 25-year storm event of 7.7 inches of rainfall in 24-hours); however, they will be accompanied by correspondingly large stream flows. For example, during the 25-year storm event the plant discharge rate will increase by a factor of 39 (144 mgd divided by 3.7 mgd) while the flow rates of the North Fork and East Fork will increase by a factor of approximately 200 over the average minimum stream flows (see Figure 4.2-2 for flood discharge rates).

The reduction in average minimum stream flows during the mining phase due to increased area of water retention bodies on the property, deep aquifer recharge, and base flow reductions caused by mine pit dewatering (Surface Water Quantity Impact) were accounted for in the mass balance computations. The net reduction in the East Fork flow due to the above factors is 2.5 mgd and 1.8 mgd in the case of the North Fork. There is an additional 2.9 mgd reduction in the East Fork flow during peak stream flow periods when water is being diverted to the surface water reservoir.

The computation of the mass loading and stream concentrations after mixing were based on the following assumptions:

- Stream flow rates were based on available values at the downstream end of the Swift property (Figure 4.2-1) since none were available precisely at the proposed points of discharge.

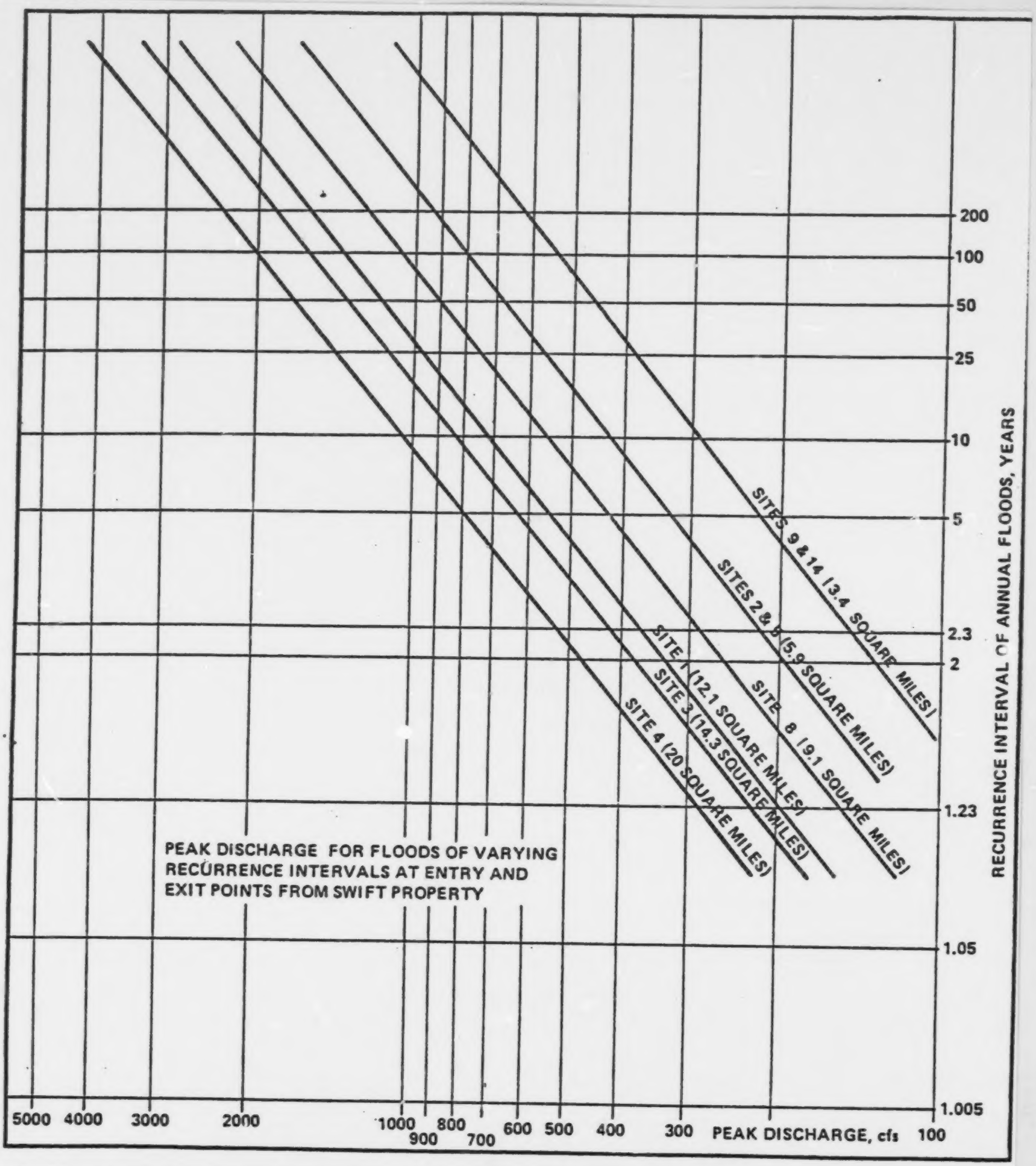


FIGURE 4.2-2

PEAK FLOOD DISCHARGES

Source: Ardaman & Associates, Inc.-Revised

U.S. EPA - REGION IV
DRAFT ENVIRONMENTAL
IMPACT STATEMENT FOR
SWIFT AGRICULTURAL CHEMICAL
CORPORATION PROPOSED
DUETTE MINE
MANATEE COUNTY, FLORIDA

- Mixing of the plant effluent with the stream flow is complete, i.e., results in a homogeneous mixture.

- The constituents behave as conservative properties, i.e., their concentrations are not affected by any process except mixing.

Mass loadings were computed with the following equation (Metcalf and Eddy, Inc., 1972):

$$\underset{\text{(lbs/day)}}{\text{Mass Loading}} = \underset{\text{(mg/l)}}{\text{Concentration}} \times \underset{\text{(mgd)}}{\text{Flow}} \times \underset{\text{(lbs/gallon)}}{8.34}$$

Constituent concentrations in the streams after mixing was predicted with the following equation (Metcalf and Eddy, Inc., 1972):

$$C_{mix} = \frac{Q_r C_r + Q_p C_p}{Q_r + Q_p} = \frac{W}{Q}$$

where C_{mix} = Constituent Concentration after mixing
C_r = Constituent Concentration in river
C_p = Constituent concentration in effluent
Q_r = River flow rate
Q_p = Wastewater flow rate
W = Combined mass loading
Q = Combined flow rate

The results of each computational step are given in Tables 4.2-A through 4.2-D, and the final results are summarized in Tables 4.2-E and 4.2-F. In order to compare the combined mass loadings in streams during mine operation with the existing mass loadings, the latter were computed for average minimum and average maximum stream discharge rates without any flow reductions due to mine operation (Table 4.2-D). The present mass loadings are then compared to loadings with the new mine in Tables 4.2-E and 4.2-F. In the same tables constituent concentrations in the streams with and without the mine in operation are summarized. Changes in the loadings and concentrations of specific parameters owing to

Table 4.2-C Combined Mass Loadings and Resultant Concentrations

Average Minimum Stream Flow

	EAST FORK DISCHARGE 002			NORTH FORK DISCHARGE 003		
Parameter	Combined Flow mgd	Combined Loading lbs/day	Concentration mg/l	Combined Flow mgd	Combined Loading lbs/day	Concentration mg/l
Total Nitrogen, as N	4.46	43.9	1.2	3.17	24.0	0.91
Total Phosphorus, as P:						
Average	4.46	58.0	1.6	3.17	50.2	1.9
Maximum	4.46	156	4.2	3.17	139	5.3
Fluoride:						
Average	4.46	90.5	2.4	3.17	77.5	2.9
Maximum	4.46	172	4.6	3.17	152	5.7
BOD	4.46	68.3	1.8	3.17	56.9	2.1
TSS:						
Average	4.46	636	17	3.17	525	20
Maximum	4.46	1126	30	3.17	969	37
TDS	4.46	13,200	355	3.17	10,620	402

Average Maximum Stream Flow

	EAST FORK DISCHARGE 002			NORTH FORK DISCHARGE 003		
Parameter	Combined Flow mgd	Combined Loading lbs/day	Concentration mg/l	Combined Flow mgd	Combined Loading lbs/day	Concentration mg/l
Total Nitrogen, as N	197	2035	1.24	133	737	.66
Total Phosphorus, as P:						
Average	197	748	0.46	133	590	0.53
Maximum	197	846	0.51	133	679	0.61
Fluoride:						
Average	197	440	0.27	133	413	0.37
Maximum	197	521	0.32	133	487	0.44
BOD	197	1673	1.0	133	1354	1.22
TSS:						
Average	197	11,870	7.2	133	8092	7.3
Maximum	197	12,360	7.5	133	8535	7.7
TDS	197	135,510	82	133	146,850	132

Table 4.2-D Existing Stream Loadings

Average Minimum Flow

	EAST FORK			NORTH FORK		
Parameter	Concentration (mg/l)	Flow (mgd)	Loading (lbs/day)	Concentration (mg/l)	Flow (mgd)	Loading (lbs/day)
Total Nitrogen, as N	1.24	5.0	51.7	.66	3.2	17.6
Total Phosphorus, as P	.43	5.0	17.9	.50	3.2	13.3
Fluoride	.42	5.0	17.5	.31	3.2	8.3
BOD	1.0	5.0	41.7	1.2	3.2	32.0
TSS	7.0	5.0	292	7.0	3.2	187
TDS	148	5.0	6,170	126	3.2	3,360

Average Maximum Flow

	EAST FORK			NORTH FORK		
Parameter	Concentration (mg/l)	Flow (mgd)	Loading (lbs/day)	Concentration (mg/l)	Flow (mgd)	Loading (lbs/day)
Total Nitrogen, as N	1.24	200	2,070	.66	133	732
Total Phosphorus, as P	0.43	200	717	.50	133	555
Fluoride	0.22	200	367	.31	133	344
BOD	1.0	200	1,670	1.2	133	1,330
TSS	7.0	200	11,700	7.0	133	7,760
TDS	77.1	200	128,600	126	133	139,800

Table 4.2-E East Fork Manatee River, Mass Loadings and Concentrations after Mixing

Parameter	Minimum Flow				Maximum Flow			
	Mass Loadings lbs/day		Concentration mg/l		Mass Loadings lbs/day		Concentration mg/l	
	Present	With New Source	Present	With New Source	Present	With New Source	Present	With New Source
Total Nitrogen, as N	51.7	43.9	1.2	1.2	2,070	2,035	1.2	1.2
Total Phosphorus, as P:								
Average	17.9	58	0.43	1.6	717	748	0.43	0.46
Maximum		156		4.2		846		0.51
Fluoride, as F:								
Average	17.5	90.5	0.42	2.4	367	490	0.22	0.27
Maximum		172		4.6		521		0.32
Biochemical Oxygen Demand, 5-day	41.7	68.3	1.0	1.8	1,670	1,670	1.0	1.0
Total Suspended Solids:								
Average	292	636	7.0	17	11,700	11,870	7.0	7.2
Maximum		1,126		30		12,360		7.5
Total Dissolved Solids	6,170	13,200	148	355	128,500	135,500	77	82

Table 4.2-F North Fork Manatee River, Mass Loadings and Concentrations after Mixing

	Minimum Flow				Maximum Flow			
	Mass Loadings lbs/day		Concentration mg/l		Mass Loadings lbs/day		Concentration mg/l	
Parameter	Present	With New Source	Present	With New Source	Present	With New Source	Present	With New Source
Total Nitrogen, as N	17.6	24.0	0.66	0.91	732	737	0.66	0.66
Total Phosphorus, as P: Average	13.3	50.2	0.50	1.9	555	590	0.50	0.53
Maximum		139		5.3		679		0.61
Fluoride, as F: Average	8.3	77.5	0.31	2.9	344	413	0.31	0.37
Maximum		152		5.7		487		0.44
Biochemical Oxygen Demand, 5-day	32.0	56.9	1.2	2.1	1,330	1,350	1.2	1.2
Total Suspended Solids: Average	187	525	7.0	20	7,760	8,092	7.0	7.3
Maximum		969		37		8,535		7.7
Total Dissolved Solids	3,360	10,600	126	402	139,800	147,000	126	132

direct discharges from the new mine and their impact on stream water quality are discussed in Section 4.3 and 4.4 below.

4.3 East Fork of Manatee River

Nutrients - The largest increase in total phosphorus loading and resultant stream concentration is expected to occur when the minimum stream flow mixes with effluent containing the maximum expected phosphorus concentration (Table 4.2-E). Under these conditions the phosphorus concentration will increase 3.8 mg/l over the present level of 0.43 mg/l. Even if this peak phosphorus level were maintained for an extended period of time, its effect on aquatic plant growth will be minimal since nitrogen is the operationally significant nutrient limiting primary productivity in the upper Manatee River basin. This is evidenced by the unusually low nitrogen:phosphorus (N:P) ratios in the upper basin ranging from 1.63 on the East Fork to 3.30 on the North Fork. This compares with an N:P ratio of 23:1 characteristic of natural waters in general (Hutchinson, 1944) and are below the 13:1 ratio (of inorganic nitrogen to orthophosphorus) which EPA (1977) employs as the threshold for nitrogen limited aquatic systems. (See Part I, Section 4.3 - Macronutrients for further discussion.)

Under conditions of minimum stream flow and average phosphorus concentration in the mine discharge, the estimated increase in the stream phosphorus level is substantially less than the previous case and, similarly, would have a minimal effect on downstream water quality.

At maximum stream flow the increased phosphorus concentrations will hardly be detectable due to the substantially greater dilution of the effluent in the receiving waters.

Some decrease in productivity may result from the reduction in nitrogenous compounds consequential to well water dilution of the background nitrogen levels (see Section 2). This effect will be minimal in the streams themselves where light is the apparent limiting factor owing to the dense canopy of swamp forest overhanging the streams. Some incremental decrease in primary productivity and, hence, eutrophication rate may be expected in the Lake Manatee reservoir as a result of the reduced nitrogen level.

Biochemical Oxygen Demand - A 0.8 mg/l increase in BOD_5 is estimated at minimum stream flow. This is approximately one standard deviation (S.D.) from the mean BOD_5 value measured just downstream of discharge point 002 (S.D. = 0.7 mg/l at Station 4, Part I, Table 4.2-B). Hence, under present stream conditions it is not uncommon for BOD_5 levels to exceed the level predicted with the new mine.

At maximum stream flow there will be virtually no change in the stream's BOD_5 concentration.

Fluoride - Under conditions of average maximum daily stream flow the fluoride concentration in the East Fork was estimated to increase from the 0.22 mg/l background level to 0.27 mg/l at the average mine effluent loading and to 0.32 mg/l at the maximum effluent loading. Both resultant concentrations are well within the State's General Criteria for fluoride (10 mg/l) applicable to Class III fresh waters and meet, as well, state and federal criteria for drinking water supplies (1.5 and 1.4 mg/l, respectively).

At the average minimum daily stream flow during August and September, the fluoride concentration at the point of mixing may be expected to exceed the standards for drinking water supplies yet remain within the State General Criteria for fluoride applicable at the point of mixing.

Substantial dilution of stream constituents in general will occur between the point of discharge in the upper part of the river basin and the Lake Manatee reservoir. The degree of dilution can be illustrated through a comparison of average stream discharge records at U.S.G.S. Gauging Station No. 2300000 located near the present midpoint of the Lake Manatee reservoir (and abandoned in 1966) with the average discharge of the North Fork at the downstream end of the Swift property. Based on twenty-seven years of U.S.G.S. records (P. E. Lamoreaux & Associates, Inc., 1974) the average discharge at Station 2300000 during the months of August, September, and October averaged 234 cubic feet per second (cfs), roughly ten times the measured average discharge of the North Fork during the same months (Figure 4.2-1).

The effect of dilution on stream fluoride concentrations at Stations 9 and 10 (Figure 4.3-1) downstream of the site was estimated for the minimum stream discharge condition by use of a simplified mixing model (Appendix C). The estimate was predicated on simultaneously effluent discharges to the East Fork (P.O.D. 002) and to the North Fork (P.O.D. 003) containing the expected average fluoride concentration of 5.0 mg/l. At Station 9, six miles downstream of the site the estimated fluoride concentration of 1.8 mg/l (Appendix C) would be somewhat above the allowable level for water supplies but well under the 10 mg/l standard applicable at that point in the river. Near the head of the reservoir at Station 10, a fluoride concentration of 1.0 mg/l was predicted — well below the allowable level for water supplies.

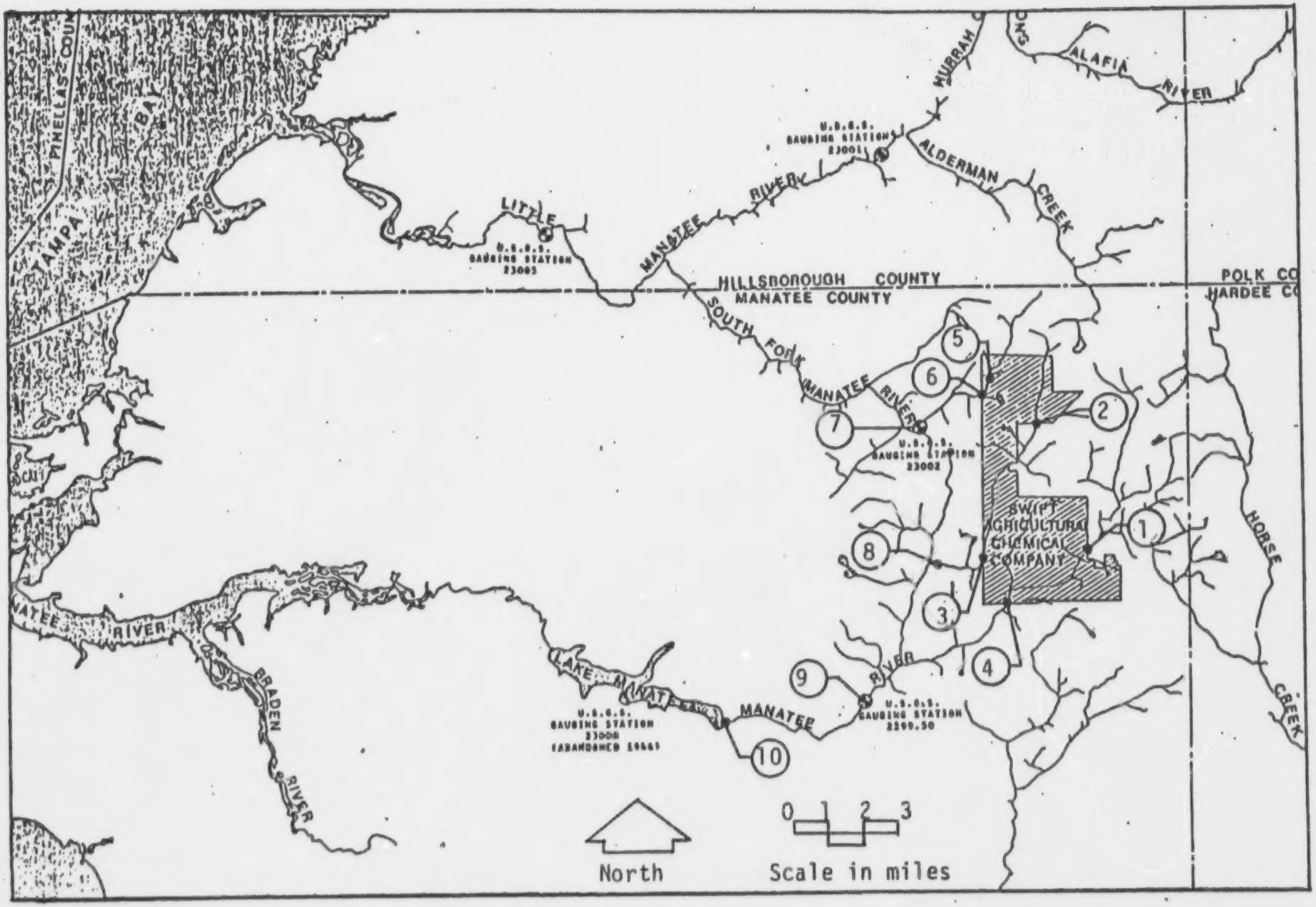

PINELLAS COUN
TAMPA
BAY
HURRAH
ALAFIA
RIVER
U.S.G.S.
GAUGING STATION
23001
ALDERMAN
CREEK
LITTLE
U.S.G.S.
GAUGING STATION
23003
MANATEE
RIVER
HILLSBOROUGH COUNTY
MANATEE COUNTY
POLK CO
HARDEE CO
SOUTH FORK
MANATEE
RIVER
U.S.G.S.
GAUGING STATION
23002
5
6
7
2
1
8
3
4
9
10
SWIFT
AGRICULTURAL
CHEMICAL
COMPANY
HORSE
CREEK
RIVER
U.S.G.S.
GAUGING STATION
2299.50
MANATEE
LAKE MANATEE
U.S.G.S.
GAUGING STATION
23008
(ABANDONED 1966)
MANATEE
RIVER
BRADEN
RIVER
North
0
1
2
3
Scale in miles

FIGURE 4.3-1
SURFACE WATER SAMPLING STATIONS

As discussed in Section 3, there is a remote possibility (estimated as about one chance in 350,000) of measured fluoride levels exceeding the 10 mg/l maximum allowable daily level and an even smaller chance of that event coinciding with the day of minimum stream flow in August or September. Assuming nevertheless that the effluent was discharged under these conditions, a resultant fluoride level of 4.6 mg/l at the point of mixing could be expected — less than half of the allowable concentration in the East Fork. At Station 9 the level would decline to approximately 3.3 mg/l.

Using the same simplified mixing model, the fluoride concentration at Station 10 near the head of the reservoir is estimated at 1.7 mg/l, approximately 13 percent above the State's allowable of 1.5 mg/l for Class I-A waters. Some reduction in the estimated 1.7 mg/l concentration could be expected if the following factors were taken in account. First, fluoride concentrations throughout the reservoir result from the mixing of continually varying inflows to the reservoir. The simplified flow model used to make the above estimates idealizes the input as a constant flow — not a variable one. When daily minimum stream flow is assumed, the resultant concentration predicted by the model is a conservative, maximum value. Actually, stream flows greater than the daily minimim (which occur on all other days of the month) would tend to dilute the fluoride concentration below the level predicted using the daily minimum flow. Due to the complexity of the mixing process, the extent of the fluoride dilution is not readily determinable.

More significantly, further reduction in fluoride levels may be expected between the head of the reservoir (Station 10) and the water treatment plant intake structure at the dam as runoff from watersheds adjacent to the lake dilutes the higher concentration flow from the upper basin.

Total Suspended Solids - The difference in total suspended solids (TSS) concentrations with and without the proposed mine will be minimal at high stream flow. The estimated increase is only 0.5 mg/l at the maximum effluent TSS loading.

At the defined minimum daily stream flow, resultant TSS concentrations with the proposed mine in operation were projected to be considerably above the average background level but still within the range of TSS baseline levels in the East Fork. The baseline TSS frequency analysis (Appendix A) predicted that TSS levels in excess of 17 mg/l — the concentration resulting from the expected 30-day average effluent discharge — may be expected under natural stream conditions 8 percent of the time. The same analysis indicated that the predicted stream TSS concentration of 30 mg/l corresponding to the maximum effluent TSS concentration will on the average be exceeded 1.4 percent of the time in the natural stream.

Total Dissolved Solids - At minimum stream flow, discharges from the mine will result in a 140 percent increase in TDS concentration. However, the maximum predicted concentration of 355 mg/l is within the 500 mg/l monthly average standard for Florida's Class I-A waters, i.e., potable water supply.

At the average maximum stream flow dissolved solids will increase by 6 percent over background levels.

4.4 North Fork of Manatee River

The minimum average flow of the North Fork at point of discharge 003 is approximately 64 percent of the minimum flow in the East Fork at discharge point 002. Since the discharge composition and flow rates from the two points are nearly the same, the effect of the discharge on the water quality of the North Fork is somewhat greater than the effect on the East Fork. In spite of this difference, none of the State's water quality standards applicable to the North Fork — a Class III water — will be exceeded over the investigated range of stream flow conditions.

Nutrients - Based on the average minimum daily flow during August, September, and October, total phosphorus concentration in the North Fork may be expected to increase a maximum of about 1.4 mg/l over the background level of 0.5 mg/l (Table 4.2-F). Under worst case conditions of minimum stream flow and maximum effluent concentration the estimated increase in the phosphorus level is 4.8 mg/l. While the projected increases in phosphorus levels are fairly substantial, the predominant role of nitrogen as the growth limiting nutrient in the North Fork as in the East Fork minimizes the impact of the phosphorus loading on the stream water quality.

At the maximum stream flow the estimated elevations in phosphorus concentrations will be substantially less, increasing by 6 percent over background at the average effluent phosphorus concentration and 20 percent at the maximum concentration.

Biochemical Oxygen Demand - A 0.9 mg/l increase in the stream BOD concentration is predicted for the minimum stream flow condition. The resultant concentration of 2.1 mg/l is well within the range of observed BOD background level at Station 3 on the North Fork (0.3 to 4.0 mg/l, Part I, Table 2-I). Because of the much greater dilution virtually no change in the BOD concentration will occur at the maximum stream flow.

Fluoride - Under conditions of maximum stream flow, fluoride concentrations in the North Fork are expected to increase nominally over the average background level of 0.31 mg/l. The maximum predicted concentration of 0.44 mg/l is well within the State's applicable Class III standard as well as state and federal drinking water criteria.

At minimum stream flow and average effluent fluoride loading, the fluoride concentration is estimated to increase from 0.31 to 2.9 mg/l still well below the allowable 10 mg/l for Class III waters. At the maximum effluent fluoride loading, the concentration in the North Fork may be expected to increase to 5.7 mg/l at the point of mixing.

The extent to which fluoride is diluted by downstream flow has been previously discussed (Section 4.3) for the case of simultaneous discharges from the clay settling area to the North and East Forks.

Total Suspended Solids - The projected total suspended solids (TSS) levels in the North Fork at the maximum stream flow condition and over the full range of expected effluent TSS loadings is essentially unchanged from the average background level of 7.0 mg/l (Table 4.2-F).

At the average minimum stream flow, TSS concentrations after mixing are estimated to range from 20 mg/l at the average effluent TSS loading up to 37 mg/l at the maximum discharge concentration. While the latter value is considerably greater than the average TSS concentration observed in the North Fork at its exit from the Swift property (12 mg/l), it is well within the range of 1 to 150 mg/l reported in the baseline data on the North Fork (Part I, Table 2-I). Further, the frequency analysis of background TSS level (Appendix A) suggests that on the average 13 percent of all TSS measurements at Stations 2 and 3 may be expected to exceed 37 mg/l under undisturbed stream conditions.

Total Dissolved Solids - A substantial increase in the TDS level is likely under minimum stream flow conditions. Nevertheless, the predicted concentration of 402 mg/l which represents the average maximum level for the months of discharge is well below the 1000 mg/l maximum level allowed by the State's Class I-A (Potable Water Supply) standard and satisfies the 500 mg/l monthly average criteria as well.

5. HYPOTHETICAL FAILURE OF CLAY SETTLING AREA EMBANKMENT

5.1 Introduction

The impact of a hypothetical failure of the clay settling area embankment on the water quantity, quality, and biology of the receiving water and adjacent wetlands is evaluated below beginning with a description of the event and a brief discussion of its probability of occurrence.

The impact analysis was predicated on a ground level break in the settling area embankment at the end of the third year of mining. At that time, the 480 acre settling area will be filled to capacity with approximately 23 feet of waste clays covered with 2 feet of clarified water. Because the waste clay will continue to consolidate and strengthen with time (thereby becoming less fluid), a failure at the end of the third year represents a worst case condition. Two points of failure were considered separately — one in the west wall of the embankment in the vicinity of the steepest slope between the settling area and the streambed of the

North Fork, and a second in the south wall at the point nearest the East Fork. The hypothetical break point in the west bank is among closest of all possible break points to Lake Manatee and, therefore, is a worst case condition.

An estimate of the probability of the embankment failure (Ardaman and Associates, Inc., 1979) was based on the average value for annual risk of a modern dam failure (approximately 1 in 10,000) adjusted for hydrologic and structural conditions unique to the proposed settling area. Details of the probability analysis are presented in Appendix D and summarized below.

The most common causes of dam failure — overtopping during large floods, subsurface erosion, earthslides, and earthquakes, in order of decreasing probability — are all less likely to occur to the proposed embankment than to an average modern dam for the following reasons: accurately predictable peak water levels; favorable soil and seismic conditions; uniform embankment and foundation sections; and the rigorous design and inspection requirements of Chapter 17-9 of the Rules of the Florida Department of Environmental Regulation. Cumulatively, the above factors reduce the annual risk of failure to about one chance in 100,000. To place this low probability in prespective, the annual risk of the hypothetical settling pond failure is two hundred times less likely than a great hurricane (windspeed greater than 125 mph) striking Florida along the 50 mile stretch of Manatee and Sarasota Counties' coastline (U.S. Department of Commerce, 1972).

5.2 Water Quantity Impact

The primary concern with respect to water quantity impact is the potential reduction in safe reservoir yield of Lake Manatee and the proposed Beker reservoir. The safe yield of Lake Manatee before and after the hypothetical waste clay spill was evaluated for the present minimum reservoir operating level of 28 feet Mean Sea Level (MSL) and for the proposed minimum operating of 21 feet MSL (Ardaman and Associates, Inc., 1979). In its present condition, the safe reservoir yields for Lake Manatee at the 28 feet (MSL) and 21 feet (MSL) operating levels are 29.7 and 34.2 million gallons per day (mgd), respectively (Table 5.2-A).

The hypothesized break in the southwest corner of the embankment would release all of the clarified water and the majority of the waste clay from the settling area to the North Fork and Lake Manatee itself. The extent of the floodplain and the lake bottom that would be inundated by the clays was predicted for two concentrations of percent solids — 18.2 percent and 23.6 percent — as measured in samples of thickened clays from pilot plant runs on matrix from the proposed site. The analytical procedure by which the distributions of clays were predicted (Ardaman and Associates, Inc., 1979) is detailed in Appendix D.

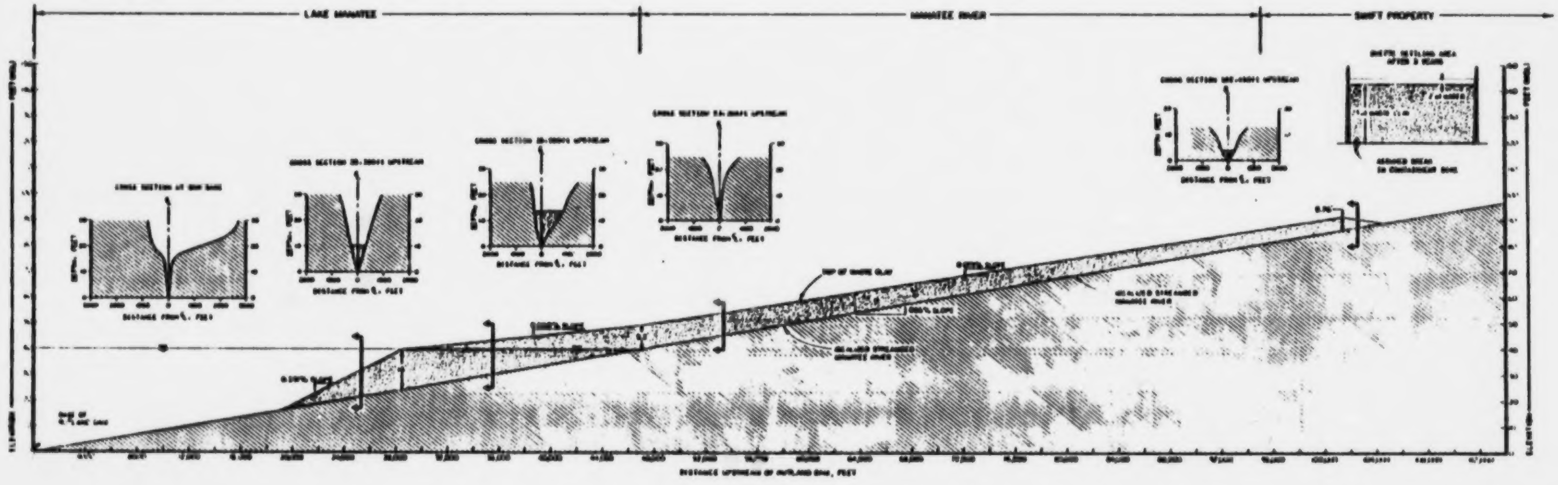
For an initial percent solids of 18.2 percent in the settling area, only a small fraction (approximately 144 acre-ft.) of the more viscous clay contained in the bottom ten feet of the area was estimated to flow into the streambed. The more viscous clay was estimated to flow a maximum of 1100 feet downstream. All of the waste clay in the top thirteen feet of the settling area, which remained near 18.2 percent solids, were predicted to flow into the streambed and reservoir. The computed final distribution of waste clay along the Manatee River for an initial percent solids of 18.2 percent is presented with the valley cross sections used in the computations in Figure 5.2-1.

Table 5.2-A Summary of Hydrologic Impact

	Minimum Operating Level (Ft. MSL)	Initial Percent Solids (%)	Live Storage Before Spill (Acre-Feet)	Live Storage After Spill (Acre-Feet)	Safe Reservoir Yield Before Spill (MGD)	Safe Reservoir Yield After Spill (MGD)
LAKE MANATEE RESERVOIR	21	18.2	20,720	18,050	34.2	31.6
	21	23.6	20,720	19,520	34.2	33.0
	28	18.2	16,100	13,950	29.7	27.2
	28	23.6	16,100	14,990	29.7	28.6
PROPOSED BEKER RESERVOIR	21	18.2	48,120	45,610	49.0	48.5
	28	18.2	43,500	40,990	44.4	43.9

Figure 5.2-1

CALCULATED FINAL WASTE CLAY DISTRIBUTION ALONG MANATEE RIVER
DUE TO HYPOTHETICAL FAILURE OF SETTLING AREA
(WASTE CLAY INITIALLY AT 10.2% SOLIDS)


LAKE MANATEE
MANATEE RIVER
SWIFT PROPERTY

Source: Ardaman and Associates, Inc. (1979)

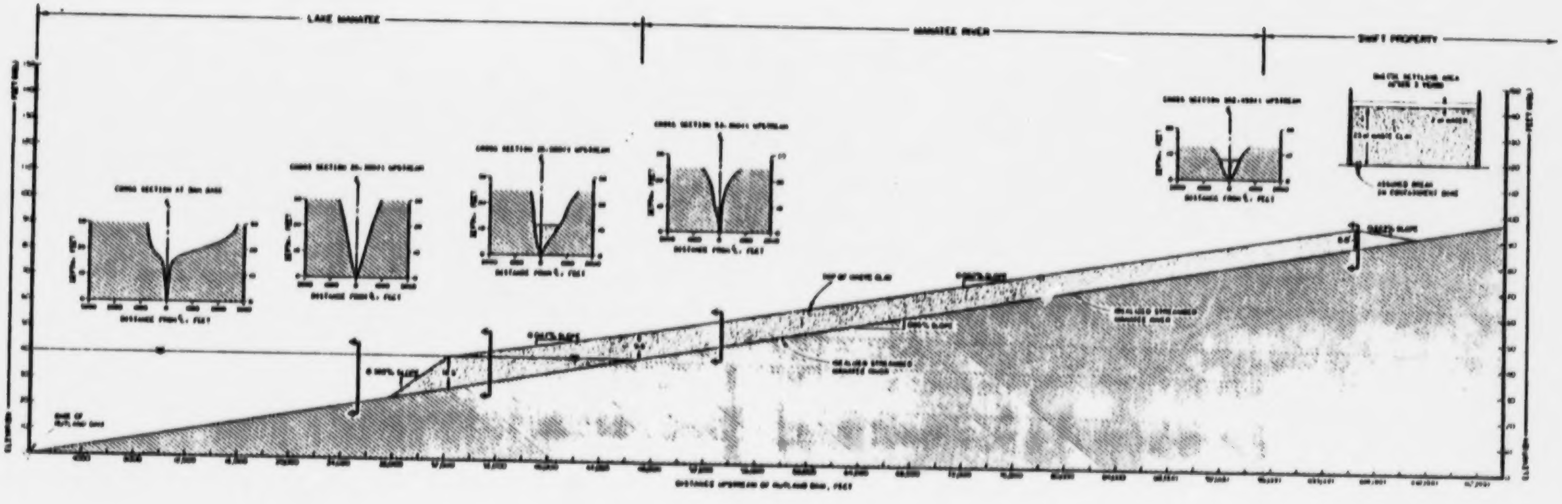
For an initial percent solids of 23.6 percent, the computations indicate that none of the more viscous clay in the bottom ten feet of the settling area would reach the streambed. Thus, only the more fluid clay in the top thirteen feet was used in computations of the distribution of waste clay along the Manatee River. The results of these computations are shown in Figure 5.2-2.

Volumes of waste clay resting below the normal and minimum operating levels of Lake Manatee were determinable from results of the clay distribution profile computations. These volumes were used to calculate the reduction in live storage due to the flow of waste clay into the reservoir. The revised values of live storage were used with the mass flow versus time curve (Figure 5.2-3) to compute revised values of safe reservoir yield for the two minimum operating levels in Lake Manatee. The values of live storage and safe reservoir yield for Lake Manatee before and after the spill of waste clay are summarized for the two minimum operating levels in Table 5.2-A. The percentage reductions in safe reservoir yield due to the spill would range from four to eight percent for the 21 feet operating level and four to nine percent for the 28 feet level.

The impact of a hypothetical failure in the south wall of the embankment on the proposed Beker Reservoir on the East Fork, Manatee River was similarly evaluated using an initial solids content of 18.2 percent. The results reported in Table 5.2-A, indicated a probable reduction in safe reservoir yield of about one percent.

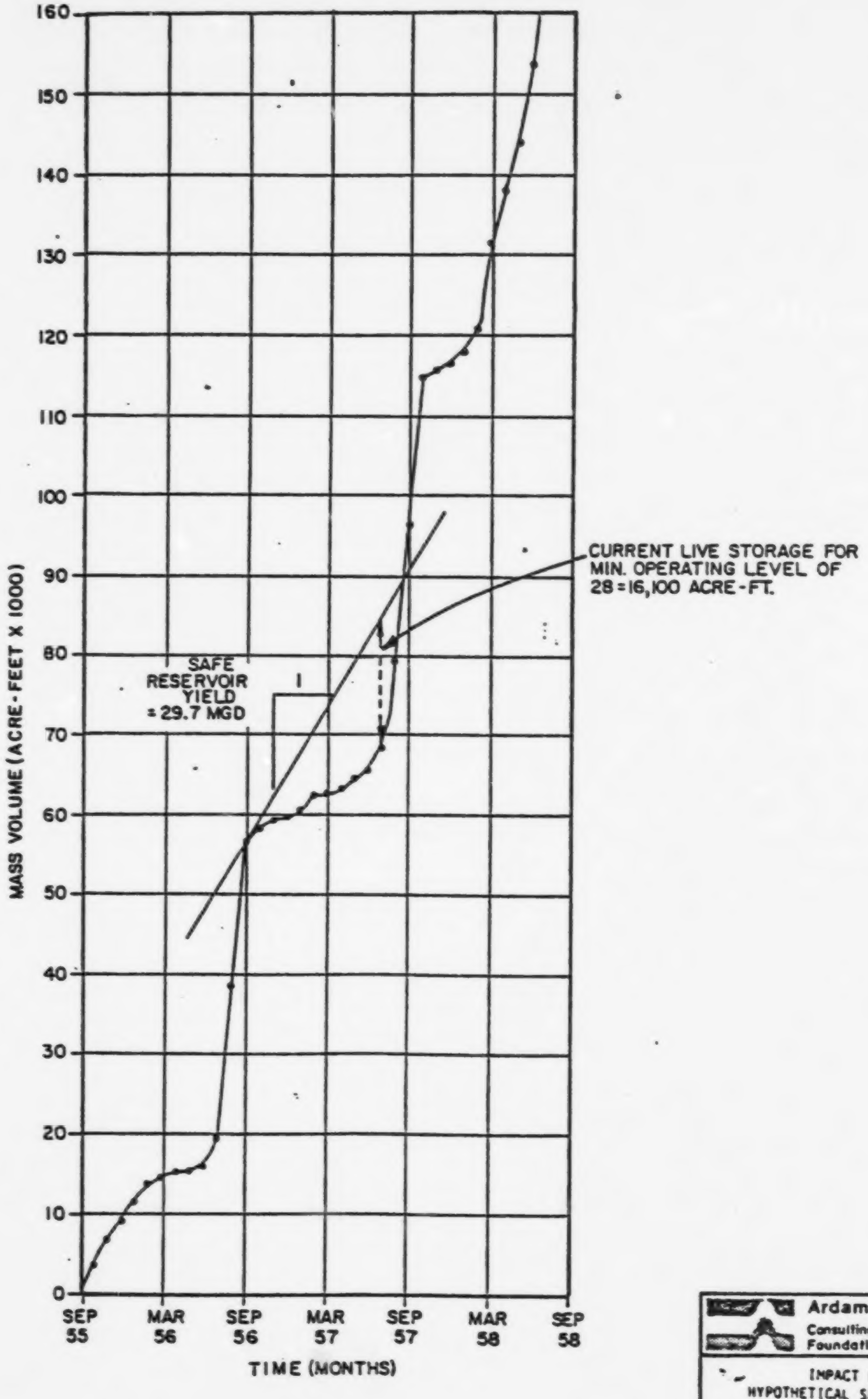
Figure 5.2-2

CALCULATED FINAL WASTE CLAY DISTRIBUTION ALONG MANATEE RIVER DUE TO HYPOTHETICAL FAILURE OF SETTLING AREA (WASTE CLAY INITIALLY AT 23.6% SOLIDS)


LAKE MANATEE
MANATEE RIVER
SWIFT PROPERTY
DISTANCE FROM ℄, FEET
TOP OF WASTE CLAY

Source: Ardaman and Associates, Inc. (1979)

Figure 5.2-3
MASS VOLUME VS. TIME FOR LAKE MANATEE



Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: KC	CHECKED BY: [illegible]	DATE: 6/29/79
FILE NO. 74-027	APPROVED BY: Gregory Lee Adams	

The conclusions of the impact evaluation with respect to surface water hydrology are summarized below:

- Failure of a settling area embankment at the Swift Duette Mine could cause a reduction in the safe reservoir yield of the existing Lake Manatee Reservoir of from 4 to 9 percent.

- Failure of a settling area embankment at the Swift Duette Mine could cause a reduction in the safe reservoir yield of the proposed Beker-Lake Manatee Reservoirs of approximately one percent.

- Waste clay from the spill will be contained within the 100 year floodplain of the Manatee River.

- The increased water level in Lake Manatee after a hypothetical spill would be less than 2 feet and would pose no danger to the dam, intake structures, or spillway structure.

- Erosion of the clay waste by rainfall runoff during the two-month period after a spill while vegetation is being re-established, will result in increased suspended solids loadings of approximately 700 ppm. This amount will not cause any significant increase in sediment load within the reservoir.

- The probability of a settling area failure is estimated to be 1 in 100,000 or one-tenth the probability of a clear water dam failure.

5.3 Water Quality Impact

Evaluation of the impact of the hypothetical settling pond failure on stream and reservoir water quality was subdivided into the following areas or phases of potential impacts:

- The effects on stream water quality evaluated through comparison with the 1971 Cities Service spill of waste clays into the Peace River.

- Short-term effects of instantaneously mixing the 1,000 acre-feet of clear water discharge from the settling area with the Lake Manatee Reservoir inventory at minimum operating level.

- Intermediate term effects of a sustained turbid water influx to Lake Manatee resulting from erosion of clays deposited in the floodplain.

- Long-term effects from the gradual expulsion of mine process water entrained in the waste clays.

- The ability of the Manatee County Water Plant to accommodate the increased contaminant loadings.

- Expected radium-226 concentrations in the raw and finished drinking water supplies.

Effects on Stream Water Quality - The initial effect of a hypothetical dam break on either the North Fork or East Fork would be a temporary stoppage of flow upstream of the break point (caused by waste clays effectively damming the stream) coupled with a complete displacement of downstream water by the advancing front of waste clays. If the failure were to occur during the characteristic "dry season" when surface runoff is negligible, stream flow might temporarily cease. Even if the stream flow persisted immediately after the spill, the extremely turbid conditions may be expected to render the river temporarily uninhabitable for all but the most tolerant of organisms.

Some insight to the order of magnitude of the effects on specific water quality parameters may be obtained by examining the impact of a documented settling pond embankment failure similar to the hypothesized accident. In December, 1971 at a Cities Service beneficiation facility in Polk County, failure of a settling pond embankment released approximately 2,600 acre-feet of waste clays — about 20 percent of the volume of the hypothesized spill — to Whidden Creek, a tributary to the Peace River. The confluence of Whidden Creek with the Peace River is some 14 miles south of Bartow, 15 miles north of Zolfo Springs, and 34 miles north of Arcadia. The U. S. Geological Survey (1972) maintained stream gauging and water quality monitoring stations at the above three cities throughout the 1972 Water Year (October, 1971 through September, 1972).

Plots of the turbidity measurements against time at each of the three stations produced two noteworthy results. First, turbidity levels at Bartow upstream of the spill were consistently higher than levels measured downstream of the spill; however, all measurements were within the present turbidity standard for the State's Class III Waters. Second, modest peaks (a maximum of 10 Jackson Turbidity Units) were recorded at the downstream stations in the month following the spill, but declined to background levels within three to four months thereafter. The U.S.G.S. sampling times evidently missed the actual peak in turbidity which occurred within hours after the spill and was sufficient to cause extensive fish kills in the river. Further, the frequency of measurement (once a month on the average) was not sufficient to reveal possible peaks in turbidity months later due to resuspension of clays by storm flows. Nevertheless, the average turbidities were at background levels within a relatively short time after the spill.

Based on the limited data the total phosphorus concentration at Zolfo Springs and Arcadia appears to have risen slightly but remained well below the average phosphorus level upstream at Bartow.

Short-Term Impact on Reservoir - The short-term impact (i.e., within days to weeks following the accident) on the Lake Manatee Reservoir was estimated by assuming complete and instantaneous mixing of the 1,000 acre-feet of clear water discharge from the clay settling area with the minimum 6,920 acre-feet of reservoir storage (corresponds to 28 foot operating level). Resultant concentrations of total suspended solids (TSS), total dissolved solids (TDS), fluoride, and total phosphorus were computed and compared with ambient water quality standards and/or present background levels of these parameters (Table 5.3-A).

The estimated resultant TSS concentration of 16.7 mg/l would be slightly greater than the present average background level of 15 mg/l. Total dissolved solids would increase to a level equivalent to the maximum observed background concentration of 202 mg/l, but stay well below the allowable 500 mg/l for Class I-A Waters. Similarly, the resultant fluoride concentration (1.0 mg/l) is near the observed maximum background concentration at the head of the reservoir (Station 10) but well below the allowable state standard of 1.5 mg/l. The predicted phosphorus concentration of 0.80 mg/l is about 60 percent above the highest base-

Table 5.3-A Short-term Water Quality Impact

Parameter[a]	Mixed Concentration[b]	Ambient Levels[c] Average	Minimum	Maximum	FDER Standard Class I-A
Total Suspended Solids	16.7	15	8	29	---
Total Dissolved Solids	204	144	103	202	500
Fluoride, as F	1.0	0.45	0.13	1.05	1.5
Total Phosphorus, as P	0.80	0.48[d]	0.43	0.53	---

[a] In units of milligrams/liter
[b] Based on expected average concentrations in effluent, Table 3-A
[c] Table 2-I, Station 10 Surface Water Quality Baseline
[d] Based on only two measurements

line value at Station 10 (based on two available measurements), but within the range of phosphorus concentration measurements for Lake Manatee as a whole (Manatee County Health Department, 1979).

Intermediate-Term Effects of Suspended Solids Loading of Lake Manatee - As in the case of the Cities Service Peace River spill, it is anticipated that the elevated total suspended solids loading in the river (as indicated by turbidity) would continue for several months, gradually tapering off to background levels as the exposed surface clays desiccate and vegetation reestablishes in the floodplain (Ardaman and Associates, Inc., 1979). A 730 mg/l increase in total suspended solids concentration during the interim period was estimated with the Universal Soil Loss Equation (Ardaman and Associates, Inc., 1979). The increased TSS loading could affect the hydrology and water quality in the reservoir in a number of ways. With regard to its potential effect on the capacity of the reservoirs it was estimated that over a two month period the additional sediment load could deposit up to 60 acre-feet in the reservoir (assuming complete entrapment), a small amount relative to the remaining dead storage of 2,000 acre-feet (Ardaman and Associates, Inc., 1979).

Regarding water quality effects, high turbidity tends to localize absorption of solar radiation near the surface, thereby reinforcing thermal stratification of the water. The net effect is to stabilize the water column and inhibit vertical mixing. One adverse result may be reduced oxygenation of subsurface waters.

The influence of increased turbidity on aquatic flora and fauna is discussed in Section 5.4, Biological Effects.

The effect of increased suspended solids concentration on the ability of the Manatee County Water Plant to treat and dispose of the additional solids was carefully evaluated because of its critical importance as a potable water supply for Manatee and Sarasota Counties. The initial step of the evaluation was to predict the concentration of suspended solids at the intake structure to the water plant (Appendix F). The analyses assumed all suspended particles entered the Lake at the surface elevation and settled in accordance with Stoke's Law (American Water Works Association, 1971). Based on a computed particle detention time of 24 days in the reservoir, Stoke's Law predicted that all particles greater than 2.5 microns in size will settle to the bottom of the reservoir before reaching the intake structure. With the known particle size weight distribution determined from a sample of waste clay from pilot plant runs with the proposed mine matrix (Ardaman and Associates, Inc., 1979a), it was conservatively estimated that 93 percent of the suspended solid would be removed. Hence, a maximum of 7 percent or 52 mg/l could be expected to enter the lowermost intake structure at 15.25 feet (MSL).

To verify the above analytical prediction, the sediment trap efficiency (as percent of suspended solids retained in the reservoir) was estimated from the empirical method developed by Bruce (1953) and presented in Chow (1964). At the capacity-inflow ratio of 0.13 computed for Lake Manatee, the observed median trap efficiency for normal ponded reservoirs is 89 percent. Hence, the predicted performance of Lake Manatee as a sedimentation basin agrees well with the observed performance of related reservoirs.

Long-Term Effects of Dissolved Constituents - Following the hypothetical accident, water entrained in clays deposited on the reservoir bottom and in the riverbed will slowly be expelled into the water column as the clays consolidate. The potential effect of fluoride, dissolved in the expelled water, on the quality of Lake Manatee as a raw water supply was examined.

The expected increase in fluoride concentration over the typical background level in Lake Manatee was estimated using the maximum predicted rate of water expulsion from the clays (Ardaman and Associates, Inc., 1979b) and the average annual flow through the reservoir. The estimate was based on a fluoride concentration of 2.5 mg/l in water expelled from the clays -- the average concentration measured in the Swift Silver City Mine effluent. The predicted increase in fluoride level -- 0.004 mg/l over the background level of 0.45 mg/l -- would have virtually no effect on the quality of the water supply.

The effect of other constituents dissolved in the expelled water, specifically phosphorus and TDS, would be equally insignificant due to their substantial dilution by the relatively large volume of natural flow through the reservoir and water storage therein.

Effects on Water Treatment Plant Capacity - The primary objective of the coagulation, flocculation, and sedimentation processes at the Manatee County Water Plant is reduction of the high natural color level in the basin waters to the maximum level of 1.0 Platinum-Cobalt Unit (PCU) allowed by F.A.C. Chapter 17-22 (Public Water Supplies). Measured color levels at Station 10, for example, ranged from 30 to 420 PCU (Part I, Table 2-I). Removal of suspended solids is of lesser importance since TSS levels in the raw water as measured at the water plant are typically less than 5 mg/l (Manatee County Utilities Department, 1979).

The intermediate-term increase in TSS levels in the reservoir will entail both beneficial and adverse effects with respect to the water plant's operation. Because of the affinity between suspended inorganic materials, such as clays, and organic compounds (EPA, 1976), such as color, some reduction in the background color levels may be expected. However, the degree of reduction is not readily predictable. On the other hand, the higher suspended solids concentration in the raw water would certainly increase the quantity of sludge, and possibly the density of sludge and coagulant (alum) dosage as well. The changes in alum dosage necessary to maintain effective coagulation-flocculation are difficult to predict since the process is influenced by a complex interaction of factors such as pH, color, turbidity, mineral content and composition, temperature, and duration and degree of agitation (AWWA, 1971). While some additional coagulant is generally required with an increase in turbidity, the dosage increase is not linear with turbidity. For the above reasons, an estimation of increased chemical costs is not practicable with the available data. It is likely however, that the additional cost of treating an intermediate level of suspended solids (EPA, 1973) over a 2 or 3 month time span would be relatively moderate compared to the total annual cost of supplying treated water to the system users.

The present sludge disposal facilities are susceptible to being overloaded in the event of a sudden increase in sludge loading. Hence, the increased rate of sludge production resulting from a hypothetical embankment failure might briefly exceed the present capacity of the drying beds and lagoon. Disposal of the small volume of additional sludge produced over a two to three month period would, therefore, require some expansion of existing drying bed and lagooning system.

Elevated orthophosphate levels in water undergoing treatment have been shown to shift the optimum pH for alum coagulation toward the acid side (AWWA, 1971). However, the 1.15 mg/l total phosphorus concentration projected in the event of the hypothetical accident is not great enough to measurably affect the coagulation process.

Effects on Radium-226 Levels in Lake Manatee Reservoir - The evaluation of changes in radioactivity levels in waters affected by the hypothetical accident focused on radium-226, the most hazardous of the several radioactive species that are potentially involved in water contamination (Radiological Environment Resource Document). Two pathways by which radium-226 might enter the Manatee River and Reservoir in the event of the hypothetical embankment failure are in association with suspended clay particles or in solution. Because of the extreme insolubility of radium-226 in water (Radiological Environment Resource Document) the former pathway is potentially the most significant. Based on the maximum expected radium-226 concentration in the waste clay of 8 pCi/g (Radiological Environment Resource Document) and the predicted TSS concentrations at the head of the reservoir and at the dam (730 mg/l and 52 mg/l, respectively), the suspended solids components of radium-226 were estimated at 5.8 and 0.4 pCi/l, respectively. The dissolved radium-226 concentration of < 1.0 pCi/l in the clear water discharge from the clay settling area is only slightly greater than the < 0.8 pCi/l background level in Lake Manatee (Radiological Environment Resource Document) and, therefore, does not represent a significant source relative to the background level. Conservatively taking the background level as 0.8 pCi/l, the total radium-226 concentrations at the head of the reservoir and at the dam for a period of several months following the hypothetical embankment failure were estimated to be 6.6 and 1.2 pCi/l, respectively. Hence, the State's radium-226 standard of 5.0 pCi/l for Class I-A waters would be slightly exceeded at the head of the reservoir, but satisfied at the critical point of water intake to the treatment plant.

Importantly, the treatment process itself could be expected to further reduce the radioactivity level. As pointed out in the Radiological Environment Impact Resource Document "any treatment of waste waters for other water quality parameters has an inherant high efficiency for radioactive species in the same water".

5.4 Biological Effects

Biological effects caused by clay wastes from the hypothetical spill will be felt in the floodplain of the Manatee River, in the wetlands associated with the river upstream from the spill site, and in the Lake Manatee Reservoir.

Most or all of the present floodplain from about 1 mile upstream of the point of embankment failure to Lake Manatee will be covered by the solids from the settling area. These solids will be 6-9 feet deep near mid-channel and progressively more shallow towards the limit of the 100 year flood zone. Based on the effects of spoil placed on hydric swamps along the Apalachicola River in the Florida panhandle (Clewell and McAninch, 1977), the effect of the solids on the Manatee River floodplain would be to kill most trees and severely stress many of the surviving trees. The cause of death and stress is oxygen depletion in the rhizosphere. As little as four inches of spoil killed trees of some species in the Apalachicola River site. Species adapted to the most hydric sites would be expected to be least affected, but these species would be subjected to the deepest inundation by solids. The effects would be more severe if the spill occurred in the growing season rather than in the dormant season.

Following the spill the new substrate would be available for revegetation. Smartweeds, cattails, and other species adapted to wet clays in mine sites would form a rather dense herbaceous cover within a year after the spill. As the substrate became drier, willows, saltbush, wax-myrtle, muscadine, and several other woody species would invade. Surviving trees from the original forest would have reestablished their root systems in the new substrate and would resume active growth at about the same time. Since the quantity of sand in the new substrate is high, root penetration would be sufficient for adequate anchorage of trees. The sand would also prevent the formation of deep fissures in dry periods, as would be expected in more clayey soils. Such fissures might break apart developing root systems. Vegetation adapted to these conditions will benefit from the high fertility of the clayey soils, as long as aeration is adequate.

Theoretically, a swamp community resembling the present natural swamp will develop gradually through plant succession. Whether or not such development will occur is speculative because there is no comparable site in the region which has undergone such perturbation and which has been allowed to undergo succession without further disturbance for several decades. One of the important species in such a forest, though, would likely be red maple. This tree is common in the natural swamps, and it survived well at the Apalachicola River site. It also produces seeds prolifically.

The wetlands and associated low country surrounding the site of the spill may be affected by prolonged flooding during the rainy season. Without a well defined river channel, runoff from the lands adjacent to the floodplain will be retarded. Water will be backed up and perhaps ponded for weeks upstream from the point of the spill (Figure 5.2-1 and 5.2-2). It is difficult to predict the impact of such prolonged hydroperiods. At a minimum, native vegetation will be stressed for a short-term. Since much of the land upstream from the site is scheduled for mining, the effect of ponding is immaterial.

The spill will result in the destruction of the aquatic fauna of the river. Benthic organisms will be buried; other organisms will suffocate as their gills become clogged by the clays and silt. Few, if any, organisms will survive.

Once the clays have settled, the river will begin to be recolonized by organisms able to adapt to the new conditions. These will be opportunistic species such as oligochaetes and certain insect larvae. Species diversity will be low initially, but as vegetation becomes reestablished and the channel stabilizes, diversity will increase.

There will be several effects on Lake Manatee. A short-term effect will be the siltation and resultant turbidity immediately following the spill. Turbidity levels are expected to return to background within 2 to 3 months. There is no evidence to suggest that the solids introduced into the reservoir will cause a change in the nutrient content or balance in the reservoir. Therefore, the effect of the spill on the limnetic zone will only be a short-term reduction in productivity while turbid conditions persist.

The spill will cause an increase of the water level in the reservoir by less than 2 feet. This increase will cause a minor readjustment of hydric vegetational zonation which will constitute a negligible impact.

The greatest impact will be the destruction of the present littoral zone in the upper end of the reservoir. The rather extensive vegetation, consisting of submersed and emergent aquatic plants will be destroyed. A new littoral zone will be created on the solids which will form the new substrate. It is difficult to determine the extent of this new littoral zone, but from the angle of deposition, it is likely that this new zone will be roughly one-third as large in area as the present littoral zone. The possible reduction in area of the littoral zone will reduce the biological productivity of the reservoir.

6. MITIGATING MEASURES

The following water treatment facilities and design features of the proposed mine will serve to mitigate the potential impact of mine discharges on receiving waters:

- Wastewaters from ore transportation, washing, flotation, and waste disposal operations will be recycled to the water recirculation system for treatment in the clay settling area. In a normal rainfall year less than 0.5 percent of the water entering the clay settling area is discharged to natural surface waters; the remainder is recycled to the benefication process or lost from the system through clay absorption, evaporation, and seepage. The recirculation system, thereby, substantially reduces a potential source of water pollution.

- The 480 acre clay settling area will serve as an effective clarification facility, reducing the suspended clay solids concentration from approximately 30,000 mg/l to 30 mg/l for a removal efficiency of 99.9 percent.

- Runoff from active mining and reclamation areas, roadways, and the benefication plant area will be collected in drainage ditches and routed to the recirculation system for treatment and thereby reduce the potential for non-point source pollution.

- Domestic sewage generated during the construction phase of the mine will be treated with chemical toilets. The effluent will be trucked to a suitable disposal site. Sewage generated during the operation phase will be treated in an on-site extended aeration treatment plant, suitably sized to handle the maximum projected loading from the mine. Effluent from the plant will be discharged to the clay settling area.

The following steps will be taken to prevent the possibility of a settling area failure and release of waste clay to the Manatee River:

- The settling area will be designed by a professional engineer, registered in Florida, who is experienced in earth dam design. The design will be based on a thorough investigation of foundation and soil conditions existing at the proposed construction site. Test borings to define subsurface conditions and laboratory tests to measure the strength, compressibility, and permeability of the foundation and embankment soils will be completed prior to analysis and design of the proposed structures.

- The rules of the Department of Environmental Regulation for the design, construction, inspection, and maintenance of earthen dams promulgated under Chapter 17-9, Florida Administrative Code, will be strictly adhered to and complied with. The proposed mining operation will also comply with all other state and/or local ordinances concerning retaining dikes.

- The construction of the initial settling area will be inspected daily by a qualified representative of the design engineer to ascertain that the embankments, spillways, and control structures meet the design specifications. Prior to the introduction of waste clay into the area, the entire structure will be thoroughly inspected by the design engineer. Several locations along the embankment will be instrumented with piezometers to monitor the seepage pattern and establish that it conforms with the seepage control features of the design. Throughout the active life of the settling area, the piezometers will be read regularly at least once a month and the data forwarded to the design engineer for evaluation.

- The settling area will be visually inspected each eight-hour shift and will be thoroughly inspected on a weekly basis by operations personnel, who have been instructed by the design engineer, regarding items to be checked. The weekly inspection will consist of checking the general condition of the crest and tow inspection roads, the condition of vegetation and soil surfaces on the outside slopes and downstream from the toe, the elevation of the impounded fluid, and the piezometric level within the embankments.

- A registered professional engineer, who is experienced in the design, construction, and maintenance of earthen dams will make annual inspections of the dam systems. He will also review on a monthly basis the reports of the operations personnel. A report of his findings will be submitted to the Florida Department of Environmental Regulation.

BIBLIOGRAPHY

American Public Health Association (1976), "Standard Methods for the Examination of Water and Wastewater", 14th ed., American Public Health Association, Washington, D. C. pp. 1193

American Water Works Association, Inc. (1971), "Water Quality and Treatment: A Handbook of Public Water Supplies"; McGraw-Hill Book Company, New York, N. Y.

Ardaman and Associates, Inc. (1975), "Proposed Phosphate Mining, Swift Chemical Company, Manatee County, Florida"; Prepared for Swift Agricultural Chemicals Corporation, Bartow, Florida. January, 1975.

Ardaman and Associates, Inc. (1977), "Surface Water Hydrology Report, Swift Chemical Company, Manatee Mine Site"; Prepared for Swift Agricultural Chemicals Corporation, Bartow, Florida. May, 1977.

Ardaman and Associates, Inc. (1978), "1977 Hydrological Monitoring Program, Swift Agricultural Chemicals Corporation, Manatee County Florida"; Prepared for Swift Agricultural Chemicals Corporation, Bartow, Florida. August, 1978.

Ardaman and Associates, Inc. (1979), "Impact Evaluation, Hypothetical Failure of Initial Settling Area, Duette Mine, Manatee County, Florida"; Prepared for Swift Agricultural Chemicals Corporation, Bradenton, Florida, July 1, 1979.

Ardaman and Associates, Inc. (1979 a), Letter report to Conservation Consultants, Inc., July 20, 1979.

Ardaman and Associates (1979 b), Letter report to Conservation Consultants, Inc., July 31, 1979.

Brune, G. M. (1953), "Trap Efficiency of Reservoirs"; Transactions of the American Geophysical Union, Vol. 34, No. 3, pp. 407-418.

Chow, Ven Te (1964), "Handbook of Applied Hydrology"; McGraw-Hill Book Company, New York, N. Y.

Clewell, A. F. and H. McAninch. 1977. Effects of a fill operation on tree vitality in the Apalachicola River floodplain. Fla. Mar. Res. Publ. 26: 16-21.

Conservation Consultants, Inc. (1977), "Annual Report, Water Quality Monitoring"; Prepared for W. R. Grace and Company, Bartow, Florida. November 18, 1977.

Conservation Consultants, Inc. (1979), Personal correspondence between R. M. Eckenrod (CCI) and Ron Potts (Zellars-Williams, Inc.), March 13, 1979.

Deevey, Edward S. (1970), "Mineral Cycles"; In : Scientific American; The Biosphere; W. H. Freeman and Company, San Francisco, CA pp. 81-92.

Hollander, Myles and Douglas A. Wolfe (1973), "Nonparametric Statistical Methods:"; John Wiley and Sons, New York, pp. 503.

Horne, R. A. (1978), "The Chemistry of Our Environment"; John Wiley and Sons, New York, N. Y. pp. 869.

Hutchinson, G. Evelyn (1944), Nitrogen in the Biochemistry of the Atmosphere"; American Scientist 32: 178-195.

Hutchinson, G. Evelyn (1975), "A Treatise on Limnology, Volume I, Part 2, Chemistry of Lakes"; John Wiley and Sons, New York, pp. 474.

Larson, Ralph I. (1971), "A Mathematical Model for Relating Air Quality Measurements to Air Quality Standards"; Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina. November, 1971.

Manatee County Health Department (1979), Personal Communication.

Metcalf and Eddy, Inc. (1972), "Wastewater Engineering-Collection Treatment, Disposal"; McGraw Hill Book Company, New York, N. Y. pp. 782.

Odum, Eugene P. (1971), "Fundamentals of Ecology"; W. B. Saunders Company, Philadelphia, PA pp. 574.

P. E. LaMoreaux and Associates, Inc. (1974), "Analysis of the Surface Water Conditions of the Beker Property, Manatee County, Florida", Appended to DRI-ADA for Beker Industries Corporation, Tampa, Florida. May, 1974.

Swift Agricultural Chemicals Corporation (1978), Application for Development Approval-Development of Regional Impact, Duette Mine, April, 1978.

Swift Agricultural Chemicals Corporations (1979), National Pollutant Discharge Elimination System, Application for permit to discharge waste water, submitted to EPA January, 1979.

Tampa Bay Regional Planning Council (1978), "Areawide Water Quality Management Plan for the Tampa Bay Region"; TBRPC, St. Petersburg, Florida. June, 1978.

U. S. Environmental Protection Agency (1973), "Water Quality Criteria, 1972"; U. S. Environmental Protection Agency, Ecological Research Series, EPA R3-73-003. March, 1973.

U. S. Environmental Protection Agency (1976), "Quality Criteria for Water"; U. S. Environmental Protection Agency, Washington, D. C. pp. 255-256.

U. S. Environmental Protection Agency (1978), "Central Florida Phosphate Industry Areawide Impact Assessment Program"; Volume V, Water. U. S. Environmental Protection Agency, Region IV, Atlanta, GA. March, 1978.

U. S. Geological Survey (1972), "Water Resources Data for Florida, Water Year 1972"; U. S. Department of Interior, Geological Survey, Tallahassee, Florida.

U. S. Geological Survey (1978), "Water Resources Data for Florida, Water Year 1977"; Volume 3A: Southwest Florida. U. S. Department of Interior, Geological Survey, Tallahassee, Florida.

Total Suspended Solids Concentration Frequency Analysis

This appendix illustrates the methodology used to estimate the probable frequency of occurrence of total suspended solids (TSS) concentrations in excess of the 30 mg/l average and the 60 mg/l maximum effluent limitations applied to phosphate rock mining and processing operations. The method was developed by Larsen (1971) for relating air quality measurements to air quality standards. The mathematical model is predicated on a lognormal frequency distribution which air quality data tend to fit. Total suspended solids concentrations in the Upper Manatee River Basin also tend to be lognormally distributed. The nearly linear plot of ln(TSS concentration, X) versus cumulative frequency of observations greater than X (Figures A-1 and A-2) is evidence of this fact.

In the following frequency analysis, TSS measurements from Stations 1 and 4 on the East Fork were considered as one sample of the same population. The similar distributions of TSS measurements at the two sites as illustrated in Figure A-1 support this approach. The same approach was used to analyze data from Stations 2 and 3 on the North Fork.

The algorithm below was adapted from Larsen's (1971) frequency analysis method. The East Fork data are used for illustrative purposes while the results from both the North Fork and East Fork analyses are summarized in Step 6.

Step 1:

Rank the TSS measurements in descending order. Data from Stations 1 and 4 of Table 2-c are so ranked in Columns 1 and 2 of Table A-1.

Step 2:

Compute the plotting point frequency for each rank from the empirical relationship

$$f = 100\% \left(\frac{r - 0.4}{n}\right)$$

where r = the rank order

n = the number of points

For example, f for Rank 1 is

$$f = 100 \left(\frac{1 - 0.4}{28}\right)$$

$f = 2.1429$ (Column 3, Table A-1)

Step 3:

Compute the difference between the 50th and f^{th} percentile, expressed as a probability

$$\text{Probability, } P = \frac{50 - f}{100}$$

Continuing the example from Step 2, for f = 2.1429,

$$P = \frac{50 - 2.1429}{100} = 0.4786 \text{ (Column 4, Table A-1)}$$

Step 4:

From an upper tail probability table for the standard normal distribution (Table A-2) determine the number of standard deviations, Z, corresponding to the probability computed in Step 3. For example, for the probability P = 0.4786,

$Z = 2.026$ (Column 5, Table A-1)

Step 5:

Determine the linear regression equation for ln[concentration] as a function of z. For the East Fork, the equation is

$$\ln C = 0.70032\, z + 1.85792 \qquad \text{Eqn. 1}$$

This equation is plotted in Figure A-1 (after converting Z-values to f-values) on the same graph as the observed f-values.

Step 6:

Compute the estimated frequency with which TSS concentrations may be expected to exceed the 30 and 60 mg/l effluent limitations.

Substitute 30 mg/l into Eqn. 1

$$\ln (30) = 0.70032\, Z + 1.85792$$

and solve for Z

$$Z = \frac{3.4012 - 1.85792}{0.70032} = 2.204$$

Find the corresponding upper tail probability in the standard normal distribution table

$P\ (Z \leq 2.204) = 0.4862$

Then reverse Step 3 to obtain the desired frequency estimate

$$f^*\ (X \geq 30\ \text{mg/l}) = 50 - (.4862)(100)$$
$$= 1.4\%$$

where the asterisk denotes a predicted frequency.

Repeating Step 6 with the 60 mg/l maximum limit results in

$$f^*\ (X \geq 60\ \text{mg/l}) = 0.07\%$$

Applying setps 1 through 6 to the North Fork TSS data yields the following results:

Regression equation:

$$\ln X = 1.24479\ Z + 2.22714$$

$$f^*\ (X \geq 30\ \text{mg/l}) = 17\%$$

$$f^*\ (X \geq 60\ \text{mg/l}) = 6.5\%$$

TABLE A-1

Frequency Analysis Worksheet
East Fork Manatee River

Rank	Concentration	f-Value	Probability	Z-Value
1	33	2.1429	0.4786	2.026
2	27	5.7143	0.4428	1.579
3	18	9.2857	0.4071	1.323
4	12	12.8571	0.3714	1.133
5	12	16.4286	0.3357	1.061
6	12	20.0000	0.3000	0.842
7	12	23.5714	0.2643	0.720
8	9	27.1429	0.2286	0.609
9	9	30.7143	0.1929	0.504
10	9	34.2857	0.1571	0.405
11	8	37.8571	0.1214	0.309
12	8	41.4286	0.0857	0.216
13	7	45.0000	0.0500	0.126
14	6	48.5714	0.0143	0.036
15	5	52.1429	-0.0214	-0.054
16	5	55.7143	-0.0571	-0.144
17	4	59.2857	-0.0929	-0.235
18	4	62.8571	-0.1286	-0.328
19	4	66.4286	-0.1643	-0.424
20	4	70.0000	-0.2000	-0.524
21	4	73.5714	-0.2357	-0.630
22	4	77.1429	-0.2714	-0.743
23	4	80.7143	-0.3071	-0.867
24	3	84.2857	-0.3429	-1.006
25	3	87.8571	-0.3786	-1.168
26	3	91.4286	-0.4143	-1.368
27	2	95.0000	-0.4500	-1.645
28	2	98.5714	-0.4857	-2.190

TABLE A-2

CUMULATIVE NORMAL FREQUENCY DISTRIBUTION
(Area under the standard normal curve from 0 to Z)

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.6	.4998	.4998	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.9	.5000									

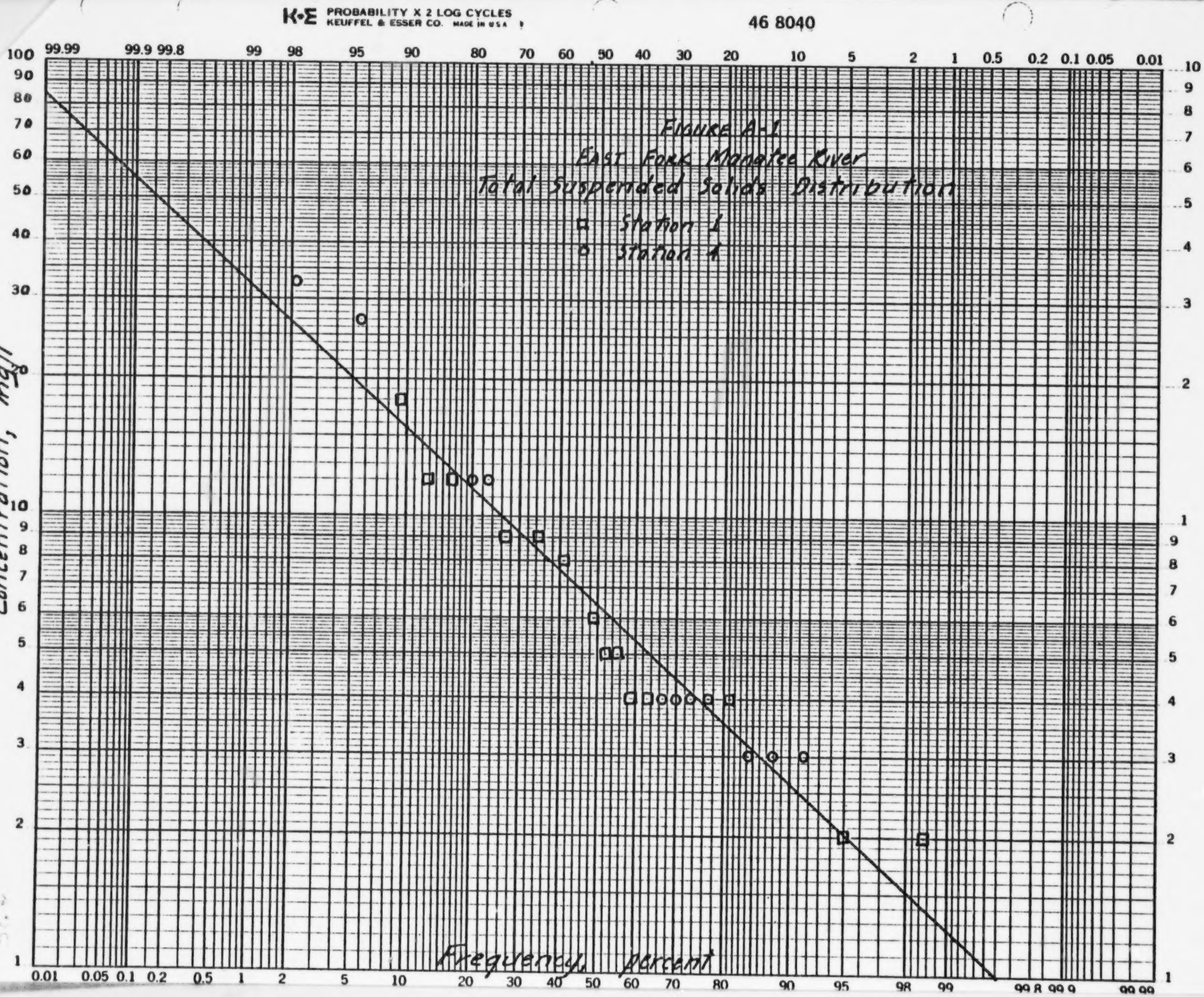
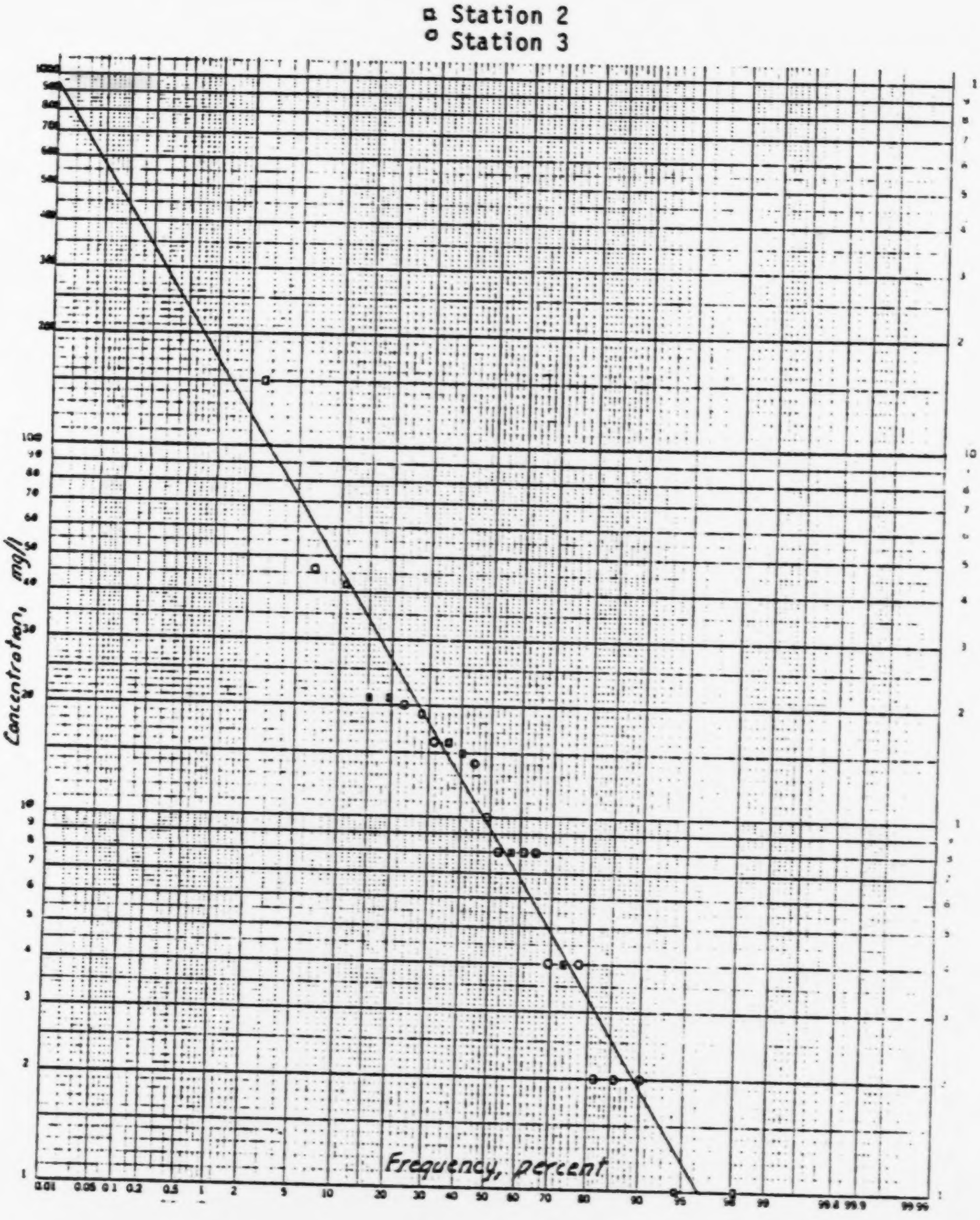


Figure A-1
East Fork Manatee River
Total Suspended Solids Distribution

Figure A-2 North Fork Manatee River, Total Suspended Solids Distribution



APPENDIX B

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
APPLICATION FOR PERMIT TO DISCHARGE WASTEWATER

FORM APPROVED
OMB No. 158–R0100

FOR AGENCY USE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
APPLICATION FOR PERMIT TO DISCHARGE WASTEWATER

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

SECTION I. APPLICANT AND FACILITY DESCRIPTION

Unless otherwise specified on this form all items are to be completed. If an item is not applicable indicate 'NA.'

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

Please Print or Type

1. Legal Name of Applicant (see instructions) 101 Swift Agricultural Chemicals Corporation

2. Mailing Address of Applicant (see instructions)
Number & Street 102a 1st Commercial Bank Bldg., 410 Cortez Rd. W.
City 102b Bradenton
State 102c Florida
Zip Code 102d 33507

3. Applicant's Authorized Agent (see instructions)
Name and Title 103a Joseph E. Davis
Project Manager
Number & Street Address 103b 1st Commercial Bank Bldg., 410 Cortez Rd. W.
City 103c Bradenton
State 103d Florida
Zip Code 103e 33507
Telephone 103f 813 (Area Code) 758-8688 (Number)

4. Previous Application If a previous application for a National or Federal discharge permit has been made, give the date of application. Use numeric designation for date. 104 – (YR) NA (MO) – (DAY)

I certify that I am familiar with the information contained in this application and that to the best of my knowledge and belief such information is true, complete, and accurate.

Printed Name of Person Signing 102e Title

Signature of Applicant or Authorized Agent 102f Date Application Signed (YR MO DAY)

18 U.S.C. Section 1001 provides that:

Whoever, in any matter within the jurisdiction of any department or agency of the United States knowingly and wilfully falsifies, conceals or covers up by any trick, scheme, or device a material fact, or makes any false, fictitious or fraudulent statement or representation, or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both.

FOR AGENCY USE

Received ___ ___ ___ (YR MO DAY)

OFFICE: ____EPA Region Number
____State

FOR AGENCY USE

5. **Facility/Activity (see instructions)** Give the name, ownership, and physical location of the plant or other operating facility where discharge(s) does or will occur.

Name 105a ______

Ownership (Public, Private or Both Public and Private) 105b ☐ PUB ☒ PRV ☐ BPP

Check block if Federal Facility and give GSA Inventory Control Number 105c ☐ FED

105d ______

Location

Street & Number 105e ______

City 105f ______

County 105g ______

State 105h ______

6. **Nature of Business** State the nature of the business conducted at the plant or operating facility. 106a ______

106b AGENCY USE

7. **Facility Intake Water** (see instructions) Indicate water intake volume per day by sources. Estimate average volume per day in thousand gallons per day.

Municipal or private water system 107a ______ thousand gallons per day

Surface water 107b 2,880 thousand gallons per day

Groundwater 107c ______ thousand gallons per day

Other* 107d 9,208 thousand gallons per day

Total Item 7 107e ______ thousand gallons per day

*If there is intake water from 'other,' specify the source. 107f Matrix moisture (3,178), Rainfall (6,030)

8. **Facility Water Use** Estimate average volume per day in thousand gallons per day for the following types of water usage at the facility. (see instructions)

Noncontact cooling water 108a ______ thousand gallons per day

Boiler feed water 108b ______ thousand gallons per day

Process water (including contact cooling water) 108c ______ thousand gallons per day

Sanitary water 108d ______ thousand gallons per day

Other* 108e ______ thousand gallons per day

Total Item 8 108f ______ thousand gallons per day

*If there are discharges to 'other,' specify. 108g ______

If there is 'Sanitary' water use, give the number of people served. 108h ______ people served

FORM APPROVED
OMB No. 158–R0100

FOR AGENCY USE

9. All Facility Discharges and other Losses; Number and Discharge (see instructions) Volume. Specify the number of discharge points and the volume of water discharged or lost from the facility according to the categories below. Estimate average volume per day in thousand gallons per day.

		Number of Discharge Points		Total Volume Used or Discharged, Thousand Gal/Day
Surface Water	109a1		109a2	
Sanitary wastewater transport system	109b1		109b2	
Storm water transport system	109c1		109c2	
Combined sanitary and storm water transport system	109d1		109d2	
Surface impoundment with no effluent	109e1		109e2	
Underground percolation	109f1		109f2	
Well injection	109g1		109g2	
Waste acceptance firm	109h1		109h2	
Evaporation	109i1		109i2	
Consumption	109j1		109j2	
Other*	109k1		109k2	
Facility discharges and volume Total item 9.	109l1		109l2	

*If there are discharges to 'other,' specify. 109m1 Water adsorbed in clay wastes.

10. Permits, Licenses and Applications
List all existing, pending or denied permits, licenses and applications related to discharges from this facility (see instructions).

	Issuing Agency	For Agency Use	Type of Permit or License	ID Number	Date Filed YR/MO/DA	Date Issued YR/MO/DA	Date Denied YR/MO/DA	Expiration Date YR/MO/DA
110	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1.								
2.								
3.								

11. Maps and Drawings
Attach all required maps and drawings to the back of this application. (see instructions)

12. Additional Information

112 Item Number	Information
107b	2,880 thousand gallons per day supplied from surface water reservoir.
108c	Composed of: 10,080 groundwater, 3,178 matrix (ore) moisture and 2,880 surface water.

SECTION I

12. Additional Information (con't)

109a2 - Surface water discharge is the direct result of accumulated rainfall from active areas of the property such as mining area, reclamation areas, and plant site.

109f2 - Underground percolation occurs from placement of wet tailings (1.89 MGD) and reject pebble (0.10 MGD), and seepage from ditches and ponds (2.28 MGD).

109j2 - Consumption is through shipment offsite of moist product, or evaporation of moisture from product due to drying facility.

109k2 - Most water loss occurs due to clay holding onto moisture after being disposed. Moisture eventually returns to groundwater system, but not during life of mine.

110(1)- Refers to Southwest Florida Water Management District consumptive use permit.

110(2)- Refers to Tampa Bay Regional Planning Council review and approval of application for development approval (ADA) filed for a development of regional impact (DRI) under Chapter 380, Florida Statutes. This is a preliminary action subject to the final permitting authority of Manatee County.

110(3)- Refers to Manatee County permitting of mining operations as a DRI and to county ordinance requirements for a master mining plan (MMP) as well as approval of a special exception (SE) to zoning requirements.

110(4)- Refers to U.S. Corps of Engineers permit required by Section 404 of the Clean Water Act.

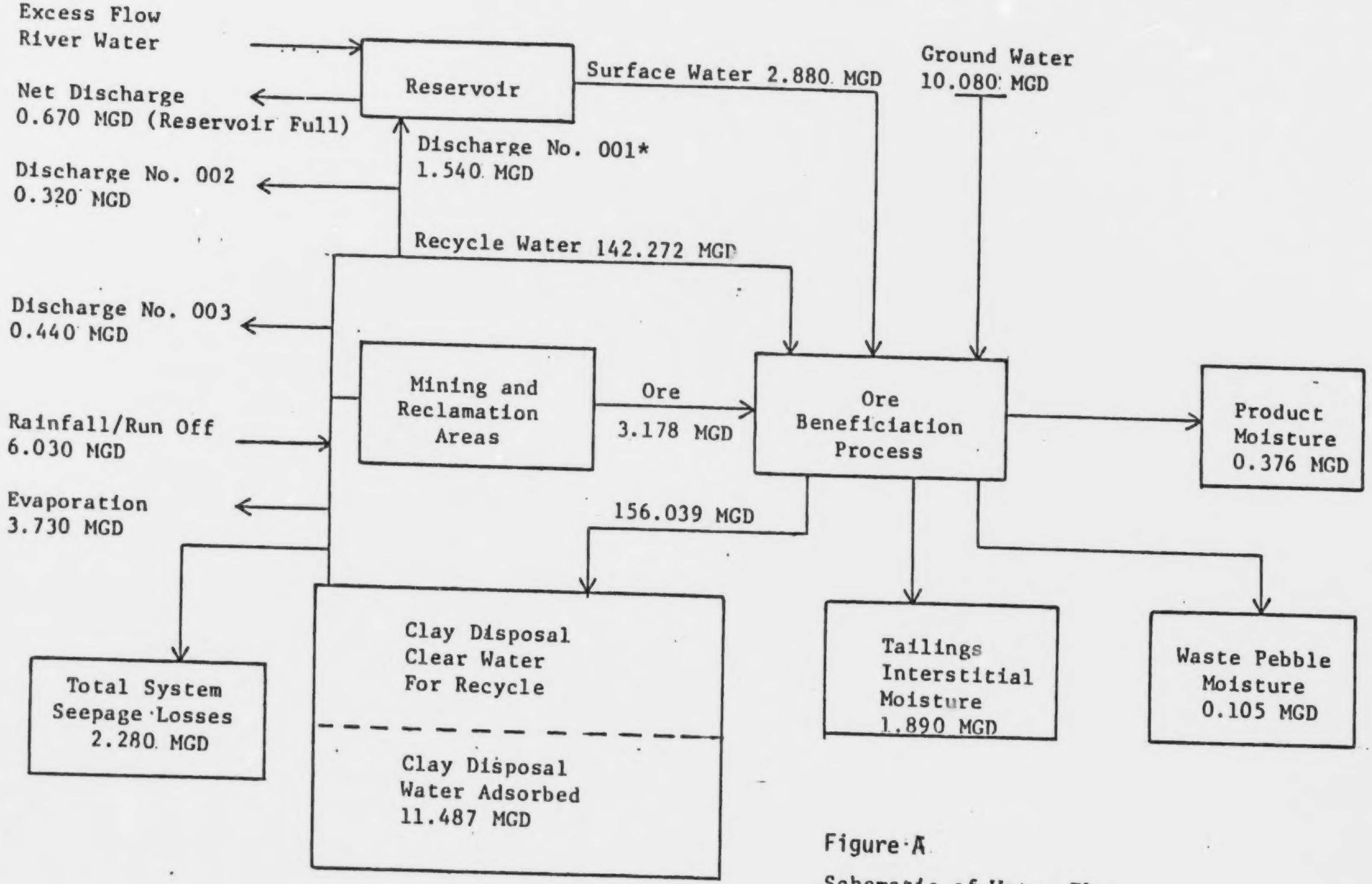
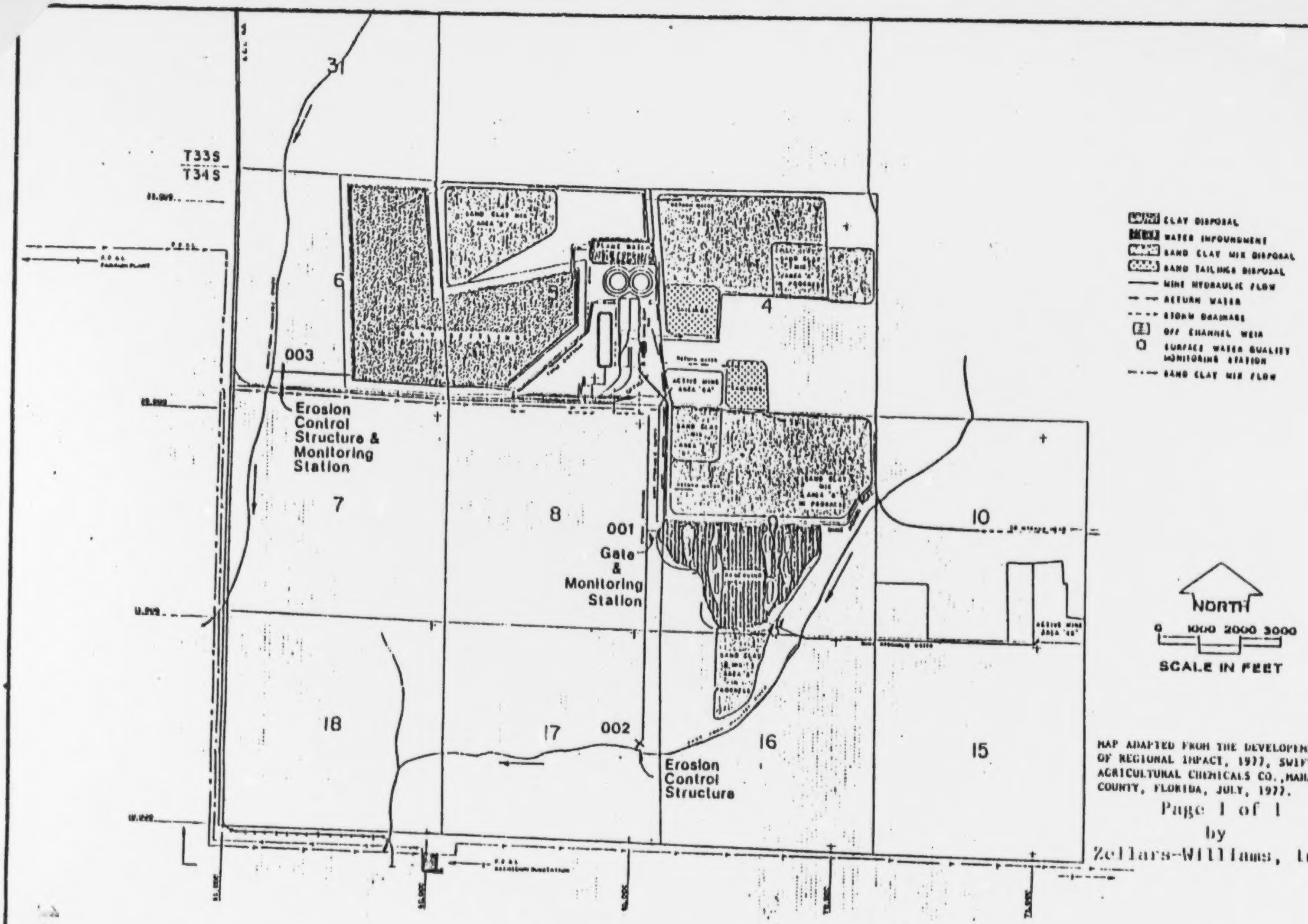

Excess Flow
River Water
Reservoir
Net Discharge
0.670 MGD (Reservoir Full)
Surface Water 2.880 MGD
Ground Water
10.080 MGD
Discharge No. 001*
1.540 MGD
Discharge No. 002
0.320 MGD
Recycle Water 142.272 MGD
Discharge No. 003
0.440 MGD
Mining and
Reclamation
Areas
Ore
3.178 MGD
Ore
Beneficiation
Process
Product
Moisture
0.376 MGD
Rainfall/Run Off
6.030 MGD
Evaporation
3.730 MGD
156.039 MGD
Clay Disposal
Clear Water
For Recycle
Clay Disposal
Water Adsorbed
11.487 MGD
Total System
Seepage Losses
2.280 MGD
Tailings
Interstitial
Moisture
1.890 MGD
Waste Pebble
Moisture
0.105 MGD

Figure A

Schematic of Water Flow
Swift Agricultural Chemicals Corporation
Manatee County, Florida
July 12, 1979
Page 1 of 1
by Zellars-Williams, Inc.

* Discharge 001 is into the reservoir.


T33S
T34S
31
6
5
4
003
Erosion Control Structure & Monitoring Station
7
8
001
Gate & Monitoring Station
10
18
17
002
Erosion Control Structure
16
15
CLAY DISPOSAL
WATER IMPOUNDMENT
SAND CLAY MIX DISPOSAL
SAND TAILINGS DISPOSAL
MINE HYDRAULIC FLOW
RETURN WATER
STORM DRAINAGE
OFF CHANNEL WEIR
SURFACE WATER QUALITY MONITORING STATION
SAND CLAY MIX FLOW
NORTH
0 1000 2000 3000
SCALE IN FEET

MAP ADAPTED FROM THE DEVELOPMENT OF REGIONAL IMPACT, 1977, SWIFT AGRICULTURAL CHEMICALS CO., MANATEE COUNTY, FLORIDA, JULY, 1977.

Page 1 of 1
by
Zellars-Williams, Inc.

FIGURE B. Location map.

FORM APPROVED
OMB No. 158–R010

FOR AGENCY USE

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. **SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY.** All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. **Discharge Serial No. and Name**
   - a. **Discharge Serial No.** (see instructions) — 201a — 002
   - b. **Discharge Name** Give name of discharge, if any. (see instructions) — 201b — East Fork
   - c. **Previous Discharge Serial No.** If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number. — 201c — NA
2. **Discharge Operating Dates**
   - a. **Discharge Began Date** If the discharge described below is in operation, give the date (within best estimate) the discharge began. — 202a — NA (YR) - (MO)
   - b. **Discharge to Begin Date** If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin. — 202b — 82 (YR) 11 (MO)
   - c. **Discharge to End Date** If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end. — 202c — NA (YR) - (MO)
3. **Engineering Report Available** Check if an engineering report is available to reviewing agency upon request. (see instructions) — 203 — ☐

Reproduced from best available copy.

4. **Discharge Location** Name the political boundaries within which the point of discharge is located.

				Agency Use
State	204a	Florida	204d	
County	204b	Manatee	204e	
(if applicable) City or Town	204c	NA	204f	

5. **Discharge Point Description** Discharge is into (check one): (see instructions) — 205a

☒ STR Stream (includes ditches, arroyos, and other intermittent watercourses)
☐ LKE Lake
☐ OCE Ocean
☐ MTS Municipal Sanitary Wastewater Transport System
☐ MCS Municipal Combined Sanitary and Storm Transport System

DISCHARGE SERIAL NUMBER

002

FOR AGENCY USE

Municipal Storm Water Transport System ☐ STS

Well (Injection) ☐ WEL

Other ☐ OTH

If 'other' is checked, specify — 205b

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude	206a	27 DEG 31 MIN 22 SEC
Longitude	206b	82 DEG 07 MIN 19 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge.(see instructions) — 207a — East Fork Manatee River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete Item 8. — 207b

For Agency Use

Major	Minor	Sub

207c

For Agency Use

303e

8. Offshore Discharge

a. Discharge Distance from Shore — 208a — NA feet

b. Discharge Depth Below Water Surface — 208b — NA feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) — 209a

☐ (con) Continuous

☒ (int) Intermittent * (See item 26)

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. — 209b — 7 days per week

c. Discharge Occurrence — Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) — 209c

☐ JAN	☐ FEB	☐ MAR	☐ APR
☐ MAY	☐ JUN	☐ JUL	☒ AUG
☒ SEP	☐ OCT	☐ NOV	☐ DEC

Complete Items 10 and 11 if "intermittent" is checked in Item 9.a. Otherwise, proceed to Item 12.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. — 210 — 115,581 thousand gallons per discharge occurrence. * (See item 26)

Reproduced from best available copy.

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. — 211a — 24 hours per day

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. — 211b — 1 discharge occurrences per day

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. — 212 — From 8 month to 9 month

DISCHARGE SERIAL NUMBER

002

FORM APPROVED
OMB No. 158–R0100

FOR AGENCY USE

13. Activity Description Give a narrative description of activity producing this discharge.(see instructions)

213a Mining, beneficiation and drying of phosphate rock.

14. Activity Causing Discharge For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the Instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

Reproduced from best available copy.

a. Raw Materials

214a

SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
NA				

b. Products

214b

SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
1475	Phosphate Rock	10	Q-1	001, 003

DISCHARGE SERIAL NUMBER

002

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a Narrative: Waste sands and clays are pumped to settling areas where the solids settle out by gravity and the clarified water is recycled to the plant. Excess water accumulated during periods of heavy rainfall is discharged from the property. Other discharges may be caused by unscheduled plant shutdowns.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b (1) RECYCL. (2) PSEDIM. (3) ________.
(4) ________. (5) ________. (6) ________.
(7) ________. (8) ________. (9) ________.
(10) ________. (11) ________. (12) ________.
(13) ________. (14) ________. (15) ________.
(16) ________. (17) ________. (18) ________.
(19) ________. (20) ________. (21) ________.
(22) ________. (23) ________. (24) ________.
(25) ________.

FORM APPROVED
OMB No. 158–R0100

DISCHARGE SERIAL NUMBER

002

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	X
Ammonia 00610		Iron 01045	X
Organic nitrogen 00605	X	Lead 01051	
Nitrate 00620	X	Magnesium 00927	X
Nitrite 00615	X	Manganese 01055	
Phosphorus 00665	X	Mercury 71900	
Sulfate 00945	X	Molybdenum 01062	
Sulfide 00745	X	Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940	X	Potassium 00937	X
Cyanide 00720		Sodium 00929	X
Fluoride 00951	X	Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022	X	Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	X
Calcium 00916	X	Phenols 32730	
Cobalt 01037		Surfactants 38260	X
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	X

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

Reproduced from best available copy.

DISCHARGE SERIAL NUMBER

002

FOR AGENCY USE

17. **Description of Intake and Discharge**

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16: ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Gallons per day 00056	NA	NA	1,959 x 10^3	0	72,000 x 10^3	Cont		
pH Units 00400	NA	NA	X	>6.0	<9.0	Annual	1	G
Temperature (winter) °F 74028	NA	NA	55			Annual	1	G
Temperature (summer) °F 74027	NA	NA	90			Annual	1	G
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310	NA	NA	2.9			Annual	1	G
Chemical Oxygen Demand (COD) mg/l 00340	NA	NA	NA	NA	NA	NA		
Total Suspended (nonfilterable) Solids mg/l 00530	NA	NA	2.0			Cont		
Specific Conductance micromhos/cm at 25° C 00095	NA	NA	X	500	1,000	Cont		
Settleable Matter (residue) ml/l 00545	NA	NA	NA	NA	NA	NA		

*Other discharges sharing intake flow (serial numbers).(see instructions)

*(001, 003; weighted averages)

FORM APPROVED
OMB No. 158–R0100

DISCHARGE SERIAL NUMBER
002

FOR AGENCY USE

17. (Cont'd.)

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Copper 01042	NA	NA	0.01			Annual	1	G
Oil and Grease 00550	NA	NA	<5			Annual	1	G

18. **Plant Controls** Check if the following plant controls are available for this discharge. 218

Alternate power source for major pumping facility. ☐ APS

Alarm or emergency procedure for power or equipment failure ☐ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. **Water Treatment Additives** If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

a. Name of Material(s) 219a NA

b. Name and address of manufacturer 219b NA

c. Quantity (pounds added per million gallons of water treated). 219c NA

PA Form 7550-23 (7-73)

DISCHARGE SERIAL NUMBER
002

FOR AGENCY USE

d. Chemical composition of these additives (see instructions). 219d NA

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions) 220

Boiler Blowdown	☐ BLBD
Boiler Chemical Cleaning	☐ BCCL
Ash Pond Overflow	☐ APOF
Boiler Water Treatment — Evaporator Blowdown	☐ EPBD
Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices	☐ OCFP
Condense Cooling Water	☐ COND
Cooling Tower Blowdown	☐ CTBD
Manufacturing Process	☐ MFPR
Other	☐ OTHR

21. Discharge/Receiving Water Temperature Difference

Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)

Summer 221a NA °F.

Winter 221b NA °F.

22. Discharge Temperature, Rate of Change Per Hour 222 NA °F./hour

Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)

23. Water Temperature, Percentile Report (Frequency of Occurrence)

In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	NA °F	°F	°F	°F
b. Discharge Water Temperature	223b	NA °F	°F	°F	°F

24. Water Intake Velocity (see instructions) 224 NA feet/sec.

25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions) 225 NA minutes

FORM APPROVED
OMB No. 158-R0100

FOR AGENCY USE

DISCHARGE SERIAL NUMBER

002

26. Additional Information

226

Item	Information
9	Discharge is dependent upon climatic factors and therefore can be expected to be quite variable. It is intended that 50% of all rainfall discharges during months indicated will be through this discharge point.
10	(Same as for discharge #001).
11	(Same as for discharge #001).
16	(Same as for discharge #001).
17	(Same as for discharge #001, except discharge is shared with 001 and 003).

FORM APPROVED
OMB No. 158-R010

FOR AGENCY USE

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name		
a. Discharge Serial No. (see instructions)	201a	003
b. Discharge Name Give name of discharge, if any. (see instructions)	201b	North Fork
c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number.	201c	NA
2. Discharge Operating Dates		
a. Discharge Began Date If the discharge described below is in operation, give the date (within best estimate) the discharge began.	202a	- NA - (YR MO)
b. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin.	202b	82 11 (YR MO)
c. Discharge to End Date If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end.	202c	- NA - (YR MO)
3. Engineering Report Available Check if an engineering report is available to reviewing agency upon request. (see instructions)	203	☐

Reproduced from best available copy.

4. Discharge Location Name the political boundaries within which the point of discharge is located.

				Agency Use
State	204a	Florida	204d	
County	204b	Manatee	204e	
(if applicable) City or Town	204c	NA	204f	

5. Discharge Point Description
Discharge is into (check one):
(see instructions)

Stream (includes ditches, arroyos, and other intermittent watercourses)	205a	☒ STR
Lake		☐ LKE
Ocean		☐ OCE
Municipal Sanitary Wastewater Transport System		☐ MTS
Municipal Combined Sanitary and Storm Transport System		☐ MCS

153

FOR AGENCY USE

Municipal Storm Water Transport System ☐ STS

Well (Injection) ☐ WEL

Other ☐ OTH

If 'other' is checked, specify — 205b ______

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude — 206a 27 DEG 32 MIN 51 SEC

Longitude — 206b 82 DEG 08 MIN 26 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge. (see instructions) — 207a North Fork Manatee River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete Item 8. — 207b

For Agency Use		
Major	Minor	Sub

207c

For Agency Use
303e

8. Offshore Discharge

a. Discharge Distance from Shore — 208a NA feet

b. Discharge Depth Below Water Surface — 208b NA feet

9. Discharge Type and Occurrence

a. Type of Discharge. Check whether the discharge is continuous or intermittent. (see instructions) — 209a

☐ (con) Continuous

☒ (int) Intermittent

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. — 209b 7 days per week *(See item 26)

c. Discharge Occurrence — Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) — 209c

☐ JAN ☐ FEB ☐ MAR ☐ APR *

☐ MAY ☐ JUN ☐ JUL ☒ AUG

☒ SEP ☒ OCT ☐ NOV ☐ DEC

Complete Items 10 and 11 if "intermittent" is checked in Item 9.a. Otherwise, proceed to Item 12.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. — 210 159,533 thousand gallons per discharge occurrence. *

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. — 211a 24 hours per day *

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. — 211b 1 discharge occurrences per day

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. — 212 From 8 month to 10 month

DISCHARGE SERIAL NUMBER

003

FORM APPROVED
OMB No. 158–R0100

FOR AGENCY USE

13. Activity Description Give a narrative description of activity producing this discharge.(see instructions)

213a Mining, beneficiation, and drying of phosphate rock.

14. Activity Causing Discharge For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the Instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

Reproduced from best available copy.

a. Raw Materials

214a	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
	NA				

b. Products

214b	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
	1475	Phosphate Rock	10	Q-1	001, 002

DISCHARGE SERIAL NUMBER

003

FOR AGENCY USE

15. Waste Abatement

a. **Waste Abatement Practices** Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a Narrative: Waste sands and clays are pumped to settling areas where the solids settle out by gravity, and the clarified water is recycled to the plant. Excess water accumulated during periods of heavy rainfall is discharged from the property. Other discharges may be caused by unscheduled plant shutdowns.

b. **Waste Abatement Codes** Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b
(1) RECYCL . (2) PSEDIM . (3) ______ .
(4) ______ . (5) ______ . (6) ______ .
(7) ______ . (8) ______ . (9) ______ .
(10) ______ . (11) ______ . (12) ______ .
(13) ______ . (14) ______ . (15) ______ .
(16) ______ . (17) ______ . (18) ______ .
(19) ______ . (20) ______ . (21) ______ .
(22) ______ . (23) ______ . (24) ______ .
(25) ______ .

FORM APPROVED
OMB No. 158-R0100

DISCHARGE SERIAL NUMBER
003

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	X
Ammonia 00610		Iron 01045	X
Organic nitrogen 00605	X	Lead 01051	
Nitrate 00620	X	Magnesium 00927	X
Nitrite 00615	X	Manganese 01055	
Phosphorus 00665	X	Mercury 71900	
Sulfate 00945	X	Molybdenum 01062	
Sulfide 00745	X	Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940	X	Potassium 00937	X
Cyanide 00720		Sodium 00929	X
Fluoride 00951	X	Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022	X	Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	X
Calcium 00916	X	Phenols 32730	
Cobalt 01037		Surfactants 38260	X
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	X

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*. 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

Reproduced from
best available copy.

DISCHARGE SERIAL NUMBER

003

FOR AGENCY USE

17. **Description of Intake and Discharge**

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16; ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Gallons per day 00056	NA	NA	1,773 x 10^3	0	72,000 x 10^3	Cont		
pH Units 00400	NA	NA	X	>6	<9	Annual	1	G
Temperature (winter) ° F 74028	NA	NA	55			Annual	1	G
Temperature (summer) ° F 74027	NA	NA	90			Annual	1	G
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310	NA	NA	2.9			Annual	1	G
Chemical Oxygen Demand (COD) mg/l 00340	NA	NA	NA	NA	NA	NA		
Total Suspended (nonfilterable) Solids mg/l 00530	NA	NA	2.0					
Specific Conductance micromhos/cm at 25° C 00095	NA	NA	X	500	1,000	Cont		
Settleable Matter (residue) ml/l 00545	NA	NA	NA	NA	NA	NA		

*Other discharges sharing intake flow (serial numbers).(see instructions)

Form 7550–23 (7–73)

FORM APPROVED
OMB No. 158-R0100

DISCHARGE SERIAL NUMBER
003

FOR AGENCY USE

17. (Cont'd.)

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Copper 01042	NA	NA	0.01			Annual	1	G
Oil and Grease 00550	NA	NA	<5			Annual	1	G

18. Plant Controls Check if the following plant controls are available for this discharge. 218

Alternate power source for major pumping facility. ☐ APS

Alarm or emergency procedure for power or equipment failure ☐ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. Water Treatment Additives If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

a. Name of Material(s) 219a NA

b. Name and address of manufacturer 219b NA

c. Quantity (pounds added per million gallons of water treated). 219c NA

DISCHARGE SERIAL NUMBER
003

FOR AGENCY USE

d. Chemical composition of these additives (see instructions). 219d NA

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions) 220

Boiler Blowdown	☐ BLBD
Boiler Chemical Cleaning	☐ BCCL
Ash Pond Overflow	☐ APOF
Boiler Water Treatment — Evaporator Blowdown	☐ EPBD
Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices	☐ OCFP
Condense Cooling Water	☐ COND
Cooling Tower Blowdown	☐ CTBD
Manufacturing Process	☐ MFPR
Other	☐ OTHR

21. Discharge/Receiving Water Temperature Difference

Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)

Summer 221a NA °F.

Winter 221b NA °F.

22. Discharge Temperature, Rate of Change Per Hour 222 NA °F./hour

Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)

23. Water Temperature, Percentile Report (Frequency of Occurrence) In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	NA °F	°F	°F	°F
b. Discharge Water Temperature	223b	NA °F	°F	°F	°F

24. Water Intake Velocity (see instructions) 224 NA feet/sec.

25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions) 225 NA minutes

FORM APPROVED
OMB No. 158-R0100

DISCHARGE SERIAL NUMBER

003

FOR AGENCY USE

26. Additional Information

226

Item	Information
9	Discharge is dependent upon climatic factors and therefore can be expected to be quite variable. It is intended that 50% of all rainfall discharges during August and September and 100% of all rainfall discharges during October will be through this discharge point.
10	(Same as #001).
11	(Same as #001).
16	(Same as #001).
17	(Same as #001, except shared with #001 and #002).

FORM APPROVE
OMB No. 158–R0

FOR AGENCY US

☐☐☐☐☐☐☐

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal seweraç systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be repr sentative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. **Discharge Serial No. and Name**
   a. **Discharge Serial No.** (see instructions) — 201a — 001
   b. **Discharge Name** Give name of discharge, if any. (see instructions) — 201b — Surface Water Reservoir
   c. **Previous Discharge Serial No.** If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number. — 201c — NA
2. **Discharge Operating Dates**
   a. **Discharge Began Date** If the discharge described below is in operation, give the date (within best estimate) the discharge began. — 202a — - NA - (YR MO)
   b. **Discharge to Begin Date** If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin. — 202b — 86 3 (YR MO)
   c. **Discharge to End Date** If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end. — 202c — - NA - (YR MO)
3. **Engineering Report Available** Check if an engineering report is available to reviewing agency upon request. (see instructions) — 203 — ☐
4. **Discharge Location** Name the political boundaries within which the point of discharge is located.

				Agency Us
State	204a	Florida	204d	
County	204b	Manatee	204e	
(if applicable) City or Town	204c	NA	204f	

5. **Discharge Point Description** Discharge is into (check one): (see instructions)

Stream (includes ditches, arroyos, and other intermittent watercourses) — 205a — ☐ STR

Lake — ☐ LKE

Ocean — ☐ OCE

Municipal Sanitary Wastewater Transport System — ☐ MTS

Municipal Combined Sanitary and Storm Transport System — ☐ MCS

162

EPA Form 7550–23 (7–73)

This section contains 9 pag

001

FOR AGENCY USE

Municipal Storm Water Transport System ☐ STS

Well (Injection) ☐ WEL

Other ☒ OTH

If 'other' is checked, specify 205b Artificial Reservoir off East Fork Manatee Riv

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude 206a 27 DEG 32 MIN 09 SEC

Longitude 206b 082 DEG 07 MIN 13 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge.(see instructions) 207a Surface Water Reservoir

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete Item 8.

207b

For Agency Use		
Major	Minor	Sub

207c

For Agency Use
303e

8. Offshore Discharge

a. Discharge Distance from Shore 208a NA feet

b. Discharge Depth Below Water Surface 208b NA feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) 209a ☐ (con) Continuous ☒ (int) Intermittent

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. 209b 7 days per week *(See item 26)

c. Discharge Occurrence — Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) 209c

☒ JAN ☒ FEB ☒ MAR ☒ APR
☒ MAY ☒ JUN ☒ JUL ☒ AUG
☐ SEP ☐ OCT ☒ NOV ☒ DEC

:omplete Items 10 and 11 if "inter-
nittent" is checked in Item 9.a.
)therwise, proceed to Item 12.

0. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. 210 562,683 thousand gallons per discharge occurrence. *(See item 26)

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. 211a 24 hours per day *(See item 26)

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. 211b 1 discharge occurrences per day

'2. Maximum Flow Period Give the time period in which the maximum
'low of this discharge occurs. 212 From 6 month to 7 month

163

DISCHARGE SERIAL NUMBER

001

FORM APPROVED
OMB No. 158—R0100

FOR AGENCY USE

13. **Activity Description** Give a narrative description of activity producing this discharge.(see instructions)

213a Mining, beneficiation and drying of phosphate rock.

14. **Activity Causing Discharge** For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the Instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. Raw Materials

214a

SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
NA				

b. Products

214b

SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
1475	Phosphate Rock	10	Q-1	002,003

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a Narrative: Waste sand tailings and clay slimes are pumped to settling areas where the solids settle out by gravity, and the water is clarified and recycled to the plant. Excess water accumulated during periods of heavy rainfall will be discharged from the property. Other discharges may be caused by unscheduled plant shutdowns.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) RECYCL	(2) PSEDIM	(3)
(4)	(5)	(6)
(7)	(8)	(9)
(10)	(11)	(12)
(13)	(14)	(15)
(16)	(17)	(18)
(19)	(20)	(21)
(22)	(23)	(24)
(25)		

FORM APPROVED
OMB No. 158-R0100

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	X
Ammonia 00610		Iron 01045	X
Organic nitrogen 00605	X	Lead 01051	
Nitrate 00620	X	Magnesium 00927	X
Nitrite 00615	X	Manganese 01055	
Phosphorus 00665	X	Mercury 71900	
Sulfate 00945	X	Molybdenum 01062	
Sulfide 00745	X	Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940	X	Potassium 00937	X
Cyanide 00720		Sodium 00929	X
Fluoride 00951	X	Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022	X	Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	X
Calcium 00916	X	Phenols 32730	
Cobalt 01037		Surfactants 38260	X
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	X

Reproduced from best available copy.

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

17. **Description of Intake and Discharge** *(See item 26)

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16; ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Gallons per day 00056	NA	NA	2,046 x 10^3	0	72,000 x 10^3	Cont		
pH Units 00400	NA	NA	X	>6.0	<9.0	Annual	1	G
Temperature (winter) °F 74028	NA	NA	55			Annual	1	G
Temperature (summer) °F 74027	NA	NA	90			Annual	1	G
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310	NA	NA	2.9			Annual	1	G
Chemical Oxygen Demand (COD) mg/l 00340	NA	NA	NA	NA	NA	NA		
Total Suspended (nonfilterable) Solids mg/l 00530	NA	NA	2.0			Cont		
Specific Conductance micromhos/cm at 25° C 00095	NA	NA	X	500	1,000	Cont		
Settleable Matter (residue) ml/l 00545	NA	NA	NA	NA	NA	NA		

*Other discharges sharing intake flow (serial numbers).(see instructions)

FORM APPROVED
OMB No. 158–R0100

FOR AGENCY USE

DISCHARGE SERIAL NUMBER
001

17. (Cont'd.)

Parameter and Code 217a	Influent: Untreated Intake Water (Daily Average) (1)	Influent: In-Plant Treated Intake Water (Daily Average) (2)	Effluent: Daily Average (3)	Effluent: Minimum Value Observed or Expected During Discharge Activity (4)	Effluent: Maximum Value Observed or Expected During Discharge Activity (5)	Effluent: Frequency of Analysis (6)	Effluent: Number of Analyses (7)	Effluent: Sample Type (8)
Copper 01042	NA	NA	0.01			Annual	1	G
Oil and Grease, 00550	NA	NA	<5			Annual	1	G

18. **Plant Controls** Check if the following plant controls are available for this discharge. 218

Alternate power source for major pumping facility. ☐ APS

Alarm or emergency procedure for power or equipment failure ☐ ALM

Complete Item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. **Water Treatment Additives** If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

a. Name of Material(s) 219a NA

b. Name and address of manufacturer 219b NA

c. Quantity (pounds added per million gallons of water treated). 219c NA

DISCHARGE SERIAL NUMBER
001

FOR AGENCY USE

d. Chemical composition of these additives (see instructions).	219d	NA

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions)	220	
Boiler Blowdown		☐ BLBD
Boiler Chemical Cleaning		☐ BCCL
Ash Pond Overflow		☐ APOF
Boiler Water Treatment — Evaporator Blowdown		☐ EPBD
Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices		☐ OCFP
Condense Cooling Water		☐ COND
Cooling Tower Blowdown		☐ CTBD
Manufacturing Process		☐ MFPR
Other		☐ OTHR
21. Discharge/Receiving Water Temperature Difference Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)		
Summer	221a	NA °F.
Winter	221b	NA °F.
22. Discharge Temperature, Rate of Change Per Hour Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)	222	NA °F./hour

23. Water Temperature, Percentile Report (Frequency of Occurrence)
In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	NA °F	°F	°F	°F
b. Discharge Water Temperature	223b	NA °F	°F	°F	°F

24. Water Intake Velocity (see instructions)	224	NA feet/sec.
25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions)	225	NA minutes

FORM APPROVED
OMB No. 158–R0100

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

26. Additional Information

226

Item	Information
9	This discharge is dependent upon climatic conditions that can (and do) have considerable variation. The most discharge will occur during times of heaviest rainfall, which historically is in June and July, but may occur at other times. By the same token, there may be a month of zero discharge if there is no rainfall. It is intended that all rainfall discharges during the months indicated will be through this discharge point.
10	This is the expected amount of discharge based upon the average monthly rainfall rates of the past 15 years, for the months indicated.
11	Due to the lag times involved between a particular rainfall event and the associated runoff, discharge times can exceed one day and result in a continuous flow during perio of frequent rainfall events.
16	The constituents checked are those actually found from another of Swift's mines, with the exception of ammonia, which should not be found here and sodium, which should be found. This is because NaOH will be used at this facility, in place of NH_4OH. Radioactivity - Radium 226; Gross α activity.
17	These parameters are based on tests done at another, similar mine, and are the results of only one test series; therefore, no average, minimum, or maximum values are actually known. Effluent is shared with discharges 002 and 003. Flow figures are weighted averages for each discharge point.

APPENDIX C

ESTIMATED FLUORIDE CONCENTRATION DOWNSTREAM OF SITE AT MINIMUM STREAM FLOW

Fluoride concentrations at Station 9 and Station 10 (Figure 4-b) downstream of the proposed mine site can be computed from the following relationship adapted from Equation 15-9, Metcalf and Eddy, Inc. (1972):

$$C_{mix} = \frac{W_s + W_{002} + W_{003}}{Q_s + Q_{002} + Q_{003}}$$

where

C_{mix} = mixed stream concentration of fluoride, mg/l

W_s = background mass loading in Manatee River at downstream stations corrected for flow reduction due to mining operation

W_s/Station 9 = 30.8 lbs/day
W_s/Station 10 = 69.4 lbs/day
(Source: U.S.G.S. Water Resource Data 1966-1977 for discharge and Table 2-i of Surface Water Quality Baseline Resource Document for average concentration)

W_{002} = average mass loading from discharge point 002
= 81.7 lbs/day (Table 4-b)

W_{003} = average mass loading from discharge point 003
= 73.9 lbs/day (Table 4-b)

Q_s = average minimum flow rate of Manatee River at Station 9 during August and September corrected for flow reduction due to mining operations.
(Source: U.S.G.S. data cited above)
Q_s/Station 9 = 8.8 mgd
Q_s/Station 10 = 22.8 mgd

Q_{002} = average rate of discharge from point 002 during August and September
= 1.959 mgd (table 4-b)

Q_{003} = average rate of discharge from point 003 during August and September
= 1.773 mgd (table 4-b)

C_{mix}/Station 9 = 1.8 mg/l

C_{mix}/Station 10 = 1.0 mg/l

APPENDIX D

PROBABILITY OF A SETTLING AREA FAILURE[1]

The average value for the annual risk of a modern dam failure, based on past experience, is approximately 1 in 10,000 (Vanmarcke, 1974). Approximately 50 percent of the dams which have failed did so because of overtopping during large floods. Approximately 30 percent failed as a result of piping, i.e., subsurface erosion, and the remainder failed because of earthslides (approximately 15 percent) or earthquakes (approximately 5 percent).

The reason such a large percentage of the failures result from overtopping is because the runoff into the reservoir behind most dams cannot be predicted accurately and because a relatively small error in the amount of runoff entering a typical reservoir can have a significant effect on the increase in water level in the lake. For example, assuming no discharge, one inch of runoff from the Lake Manatee watershed would result in an increase in the level of Lake Manatee on the order of 3.5 feet. Conversely, with the same assumption, once inch of rainfall on the Duette Mine would result in an increase in the level of the initial settling area of only slightly more than one inch. Because the initial settling area will be designed so that a minimum freeboard of 5 feet will be maintained and since the maximum possible precipitation (NOAA, 1956) on the subject area is only 31 inches, the probability that the settling area will be overtopped is essentially zero.

The most common causes of piping failures are:

(1) Poor construction control, resulting in inadequately compacted or improper material in the embankment.

(2) Inferior compaction adjacent to outlet piper or other structures.

(3) Poor compaction and bond between the embankment and the foundation or abutments.

(4) Embankment and/or foundation leaks through more pervious layers and/or through differential settlement cracks in the embankment.

(5) Cracking in outlet pipes, caused by foundation settlement, spreading of the embankment, and/or deterioration.

(6) Animal burrows and drying cracks.

The first three causes of piping are related to construction defects and, with full time construction inspection by a representative of the design engineer as required by Chapter 17-9 of the Department of Environmental

---

[1] Ardaman and Associates, Inc., 1979. "Impact Evaluation, Hypothetical Failure of Initial Settling Area, Duette Mine." Prepared for Swift Agricultural Chemicals Corporation, Manatee County, Florida, July, 1979.

Regulation and as practiced by Swift, there is an extremely low probability that piping will result from these causes. Likewise, leaks through more pervious layers within the embankment can be prevented by good quality control during construction and, because the embankment section and foundation conditions are uniform throughout its length, i.e., there are no abutments for the settling area embankment, differential settlement cracks in the embankment are extremely unlikely. Because of the sandy nature of the Florida soils, positive seepage control as required by Chapter 17-9 is and will be an important design and construction consideration for the embankments surrounding the initial settling area. Furthermore, it is important to note that the waste clay itself will reduce the possibility of unexpected foundation leaks by sealing the bottom and sides of the settling area.

Settlement and spreading of embankments are associated with soft clay foundations. Subsurface exploration at the Duette Mine indicates that no such strata are present. Based on previous experience, deterioration of the asphalt-coated metal outlet conduits during the life of the planned mine is extremely remote. Consequently, piping through the outlet structure is not a realistic possibility. Drying cracks within the outer sand shell of an embankment in Florida is also not a real possibility and with adequate inspection, the probability of piping through an animal burrow is also extremely remote.

Considering all of the above, the probability of a piping failure beneath or through the embankments of the initial settling area at the Swift Duette mine are much less than would be anticipated based on prior failures of other dams.

Because of the relatively strong foundation soils existing at the site and the generally flat slopes and high safety factors required by Chapter 17-9, there is also little likelihood of a slide-related failure of the embankment. Finally, because Florida is in a very low risk earthquake zone, the probability of an earthquake-related failure is essentially zero.

Because the probability of a dam failure in general is the sum of the possibilities of the dam failing due to each possible mode of failure, the reduced probability of a settling area dam failure at the Duette Mine can be determined from the above considerations as follows (after Vanmarcke, 1974):

Let $p = \Sigma p_j$,

where $p =$ the annual risk of a conventional clear water dam failure from any cause

and $p_j =$ the annual risk due to failure mode j.

Also, let $p' =$ the annual risk of the settling area dam failing from any cause,

where $p' = \Sigma p_j' = \Sigma p_j (1-r_j) = p (1-\Sigma p_j r_j/p)$

and $r_j =$ the measure of difference in probability of the settling area dam failing compared to an average clear water dam failing for mode j

$= 1$ for over topping; $p_j/p = 50$ percent

$= 1$ for earthquake; $p_j/p = 5$ percent

$= .95$ for earth slides; $p_j/p = 15$ percent

$= 0.7$ for piping; $p_j/p = 30$ percent

Then $p' = 10^{-4}\,(1-.5(1) - .05(1) - .15(.95) - .30(.7))$

$p' = .97 \times 10^{-5}$

$= 1$ in 100,000

That is, the probability of a settling area dam failing in approximately one-tenth the probability of a conventional clear water dam failing.

APPENDIX E

ANALYSIS OF WASTE CLAY DISTRIBUTION IN MANATEE RIVER VALLEY[1]

Waste Phosphatic Clay Physical Properties

To maximize the recovery of water from the clay waste, Swift has elected to utilize a flocculating agent and thickener prior to discharging the waste clay into the initial settling area. The combined effect of the flocculant and thickener is to increase the percent solids in the clay waste from the conventional 3 to 5 percent to greater than 18 percent.

Two samples of thickened clay were obtained from the Zellars-Williams, Inc. pilot plant runs on the Swift matrix. One of the samples, Sample No. 1, had a percent solids of 23.6 percent; the other, Sample No. 2, had a percent solids of 18.2 percent. Other index properties for these samples are summarized in the following table.

TABLE 1

Index Property	Sample No. 1	Sample No. 2
Percent Solids	23.6%	18.2%
Water Content*	324%	450%
Liquid Limit	128	161
Plastic Limit	31	36
Liquidity Index	3.02	3.31

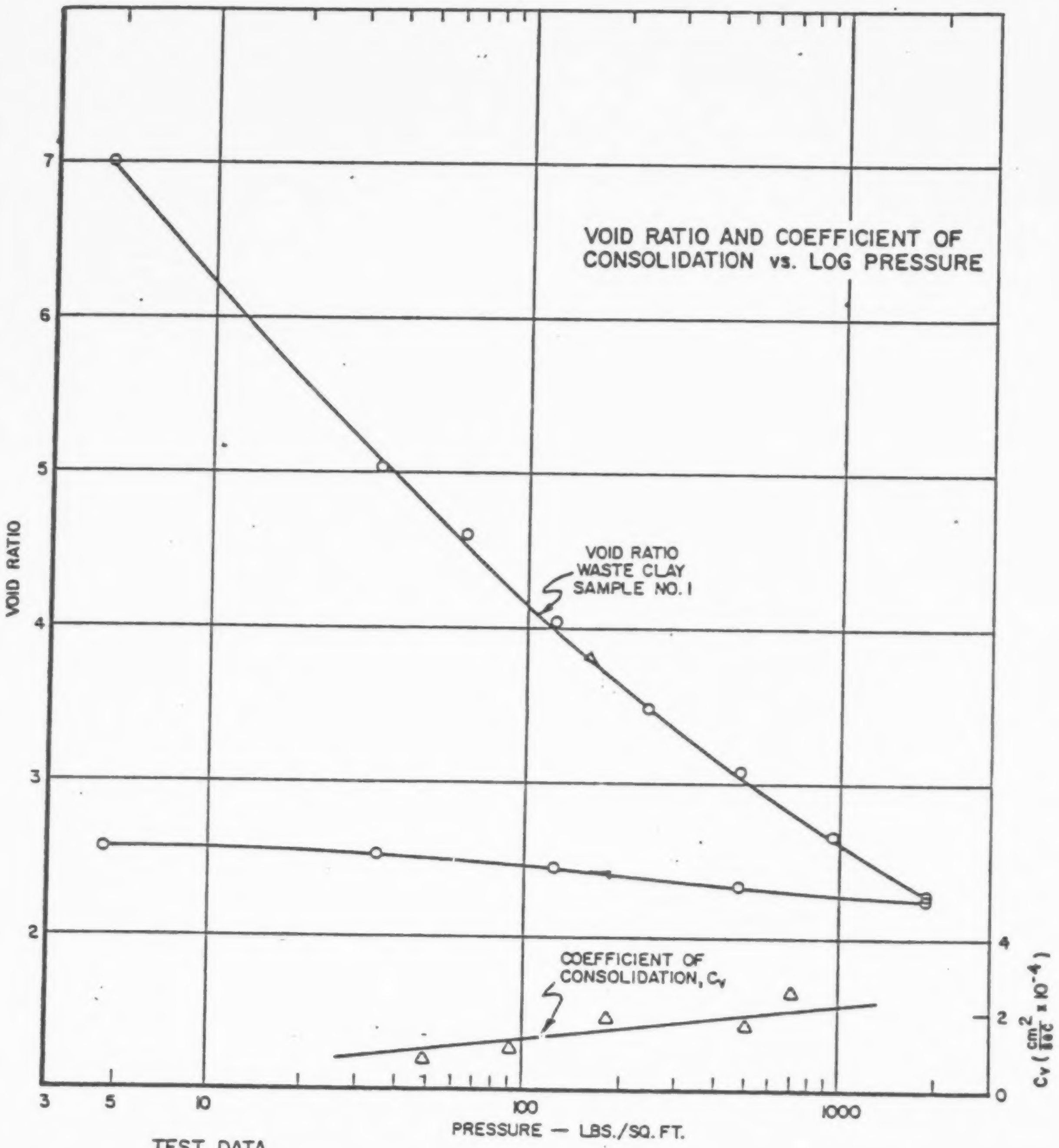
* Water Content = (Weight of Water ÷ Weight of Solids) x 100%.

To determine the consolidation characteristics of the waste clay, a one-dimensional consolidation test was performed on Sample No. 1. The results are plotted as void ratio vs. effective stress and coefficient of consolidation, c_v, vs. effective stress in Figure 2. Figure 3 presents the same results plotted as percent solids vs. effective stress.

To determine the flow characteristics and the undrained shear stength of the two samples, each sample was poured into the end compartments of a rectangular, glass-walled tank and, after the sample came to equilibrium, the bulkhead separating the compartment from the remainder of the tank was quickly pulled away allowing the waste clay to flow out into the tank. The results of the two experiments are shown in Figure 4. Based on the resulting slope geometry, the undrained shear strength of the samples was calculated using the slope stability charts presented by Taylor (1937). A copy of the applicable curve of $s_u/\gamma H$ vs. maximum stable slope angle is presented in Figure 5.

---

[1] Ardaman and Associates, 1979. "Impact Evaluation, Hypothetical Failure of Initial Settling Area, Duette Mine." Prepared for Swift Agricultural Chemicals Corporation, Manatee County, Florida, July, 1979.



TEST DATA

WASTE PHOSPHATIC CLAY
SAMPLE NO. 1

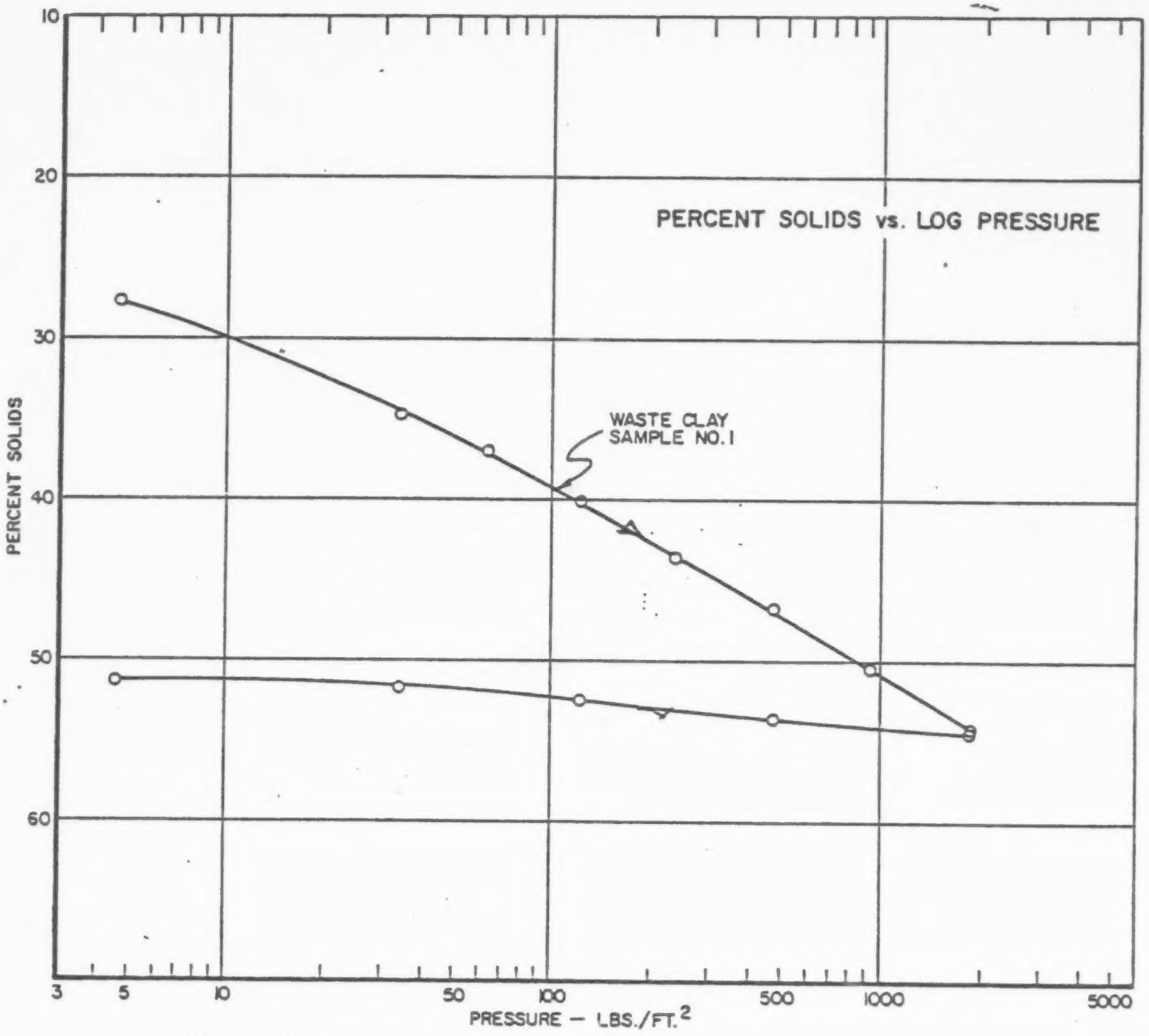
HEIGHT (INCHES) 1.04
DIAMETER (INCHES) 2.50
INITIAL MOISTURE CONTENT(%) 320
INITIAL DRY DENSITY(LBS./CU.FT.) 73.4
SPECIFIC GRAVITY 2.70 (ASSUMED)
FINAL MOISTURE CONTENT(%) 99.3
LIQUID LIMIT(%) 128
PLASTIC LIMIT(%) 31

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: DLR	CHECKED BY: ZLG	DATE: 6/29/79
FILE NO. 74-027	APPROVED BY: Gregory Lee Adams	

FIGURE 2



TEST DATA

WASTE PHOSPHATIC CLAY
SAMPLE NO. 1

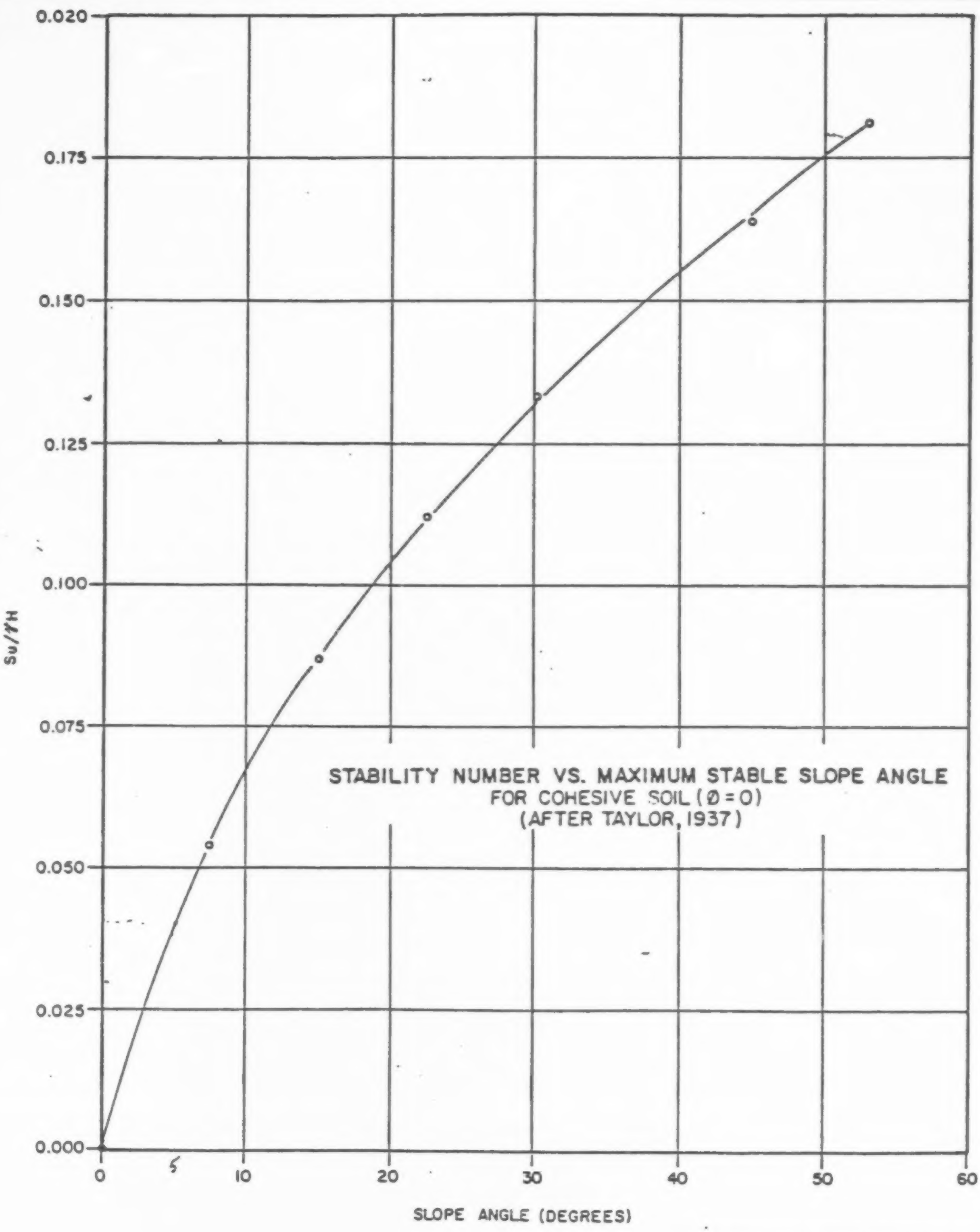
HEIGHT (INCHES) 1.04
DIAMETER (INCHES) 2.50
INITIAL MOISTURE CONTENT(%) 320
INITIAL PERCENT SOLID(%) 23.8
SPECIFIC GRAVITY 2.70(ASSUMED)
FINAL MOISTURE CONTENT(%) 99.3
FINAL PERCENT SOLIDS 50.2
LIQUID LIMIT(%) 128
PLASTIC LIMIT(%) 31

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: DLR
CHECKED BY:
DATE: 6/29/79
FILE NO. 74-027
APPROVED BY: Gregory Lee Adams

FIGURE 3



STABILITY NUMBER VS. MAXIMUM STABLE SLOPE ANGLE
FOR COHESIVE SOIL (Ø = 0)
(AFTER TAYLOR, 1937)

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics,
Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: KC	CHECKED BY: [illegible]	DATE: 6/29/79
FILE NO. 74-027	APPROVED BY: George Lee Adams	

FIGURE 5

The measured undrained strength of the two samples, along with the average strength at the liquid limit, are plotted against Liquidity Index in Figure 6. The other curve in the figure is a similar plot obtained by Skempton & Northey (1952).

Lake Manatee Reservoir

Lake Manatee is located on the Manatee River approximately 8 to 10 miles downstream from the Swift property. The following operating levels for Lake Manatee were obtained from an interoffice communication of the Manatee County Utilities Department dated June 24, 1979.

1. Maximum level of reservoir between June 15 and September 15 shall be 36 feet (MSL).
2. After September 15 the reservoir is to be raised to 39 feet (MSL).

The Corps of Engineers Phase I Inspection Report dated February, 1978, states that the top of the water supply pool is normally maintained at Elevation 40 feet (MSL). This same report gives the top of dam at Elevation 50 feet (MSL) and the top of the spillway gates (closed) at Elevation 43 feet (MSL). A stage-storage curve for the Lake Manatee Reservoir is presented in Figure 7.

The existing elevations of the intake structures at the Lake Manatee Reservoir are 15.25, 24.25, and 33.5 feet (MSL). However, information obtained from Russell & Axon, Inc. (1979) indicates that the minimum operating level for the reservoir is at Elevation 28 feet (MSL). Using a normal operating level of 40 feet (MSL) and a minimum operating level of 28 feet (MSL), we have computed a live storage for the reservoir of 16,100 acre-feet (MSL).

Additional information obtained from Russell & Axon (1979) indicates that proposed changes in the intake structure will result in a minimum operating level of 21 feet (MSL). For this condition the live storage would be increased to 20,720 acre-feet.

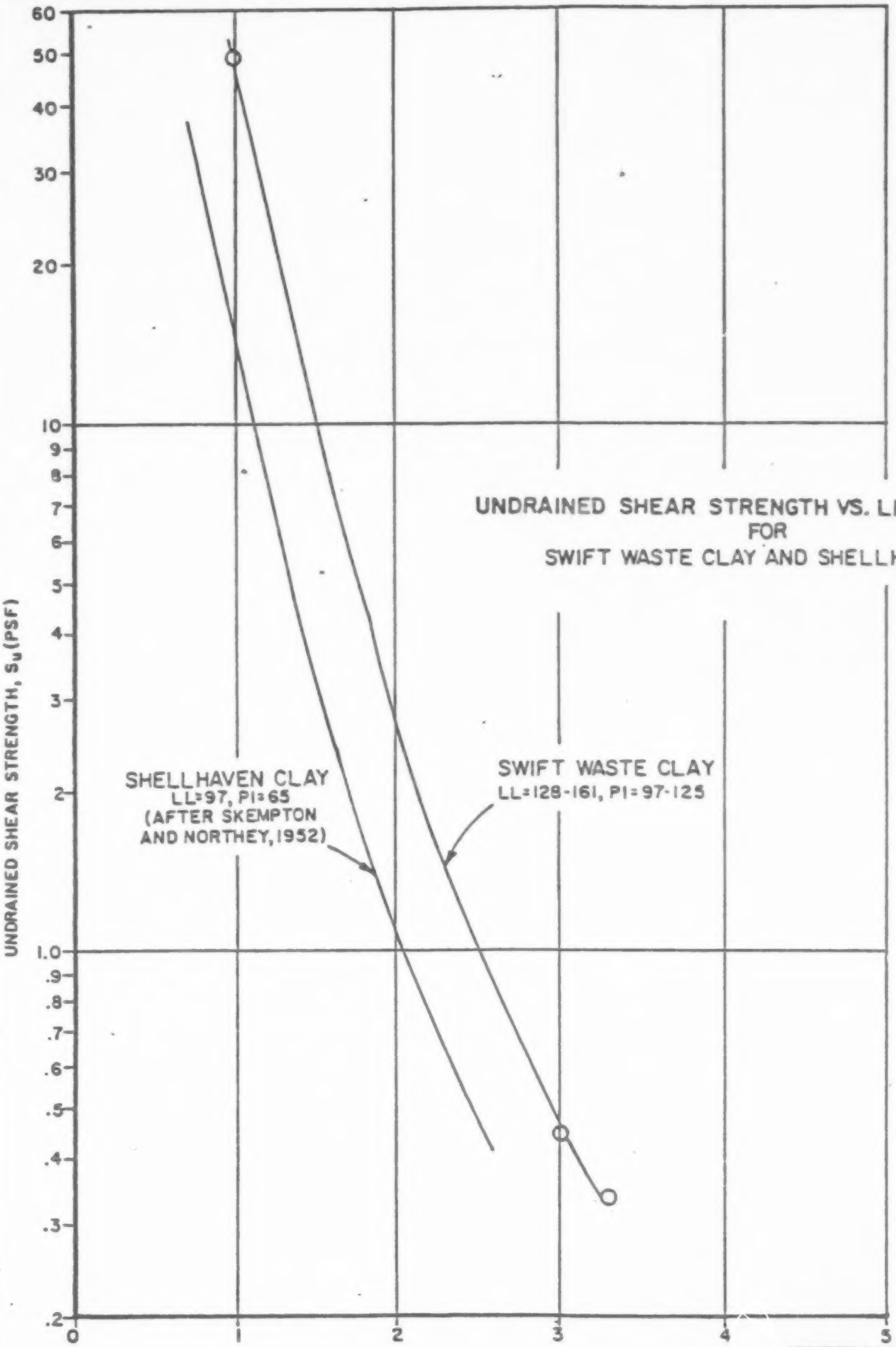
A mass volume vs. time curve for the Manatee River at the Lake Manatee dam, computed for the record drought, (estimated return frequency of 40 years) is presented in Figure 8. Using these data, the safe reservoir yields for Lake Manatee at the 28 feet (MSL) and 21 feet (MSL) operating levels are 29.7 and 34.2 MGD, respectively.

Beker Reservoir

The proposed Beker reservoir, which is on the East Fork, Manatee River, extends onto the southern portion of the Swift property. Very little design information on the proposed Beker reservoir after mining is available.

Prior to mining the Beker reservoir, at a normal operating level of 86 feet (MSL) will have a total storage capacity of 3400 acre-feet (Ardaman and Associates, Inc., 1974). Information obtained from Mr. Charles Hunsinger of the Manatee County Planning Department (1979) indicates that Beker will

K&E 19 1153 2-79 MC8964e

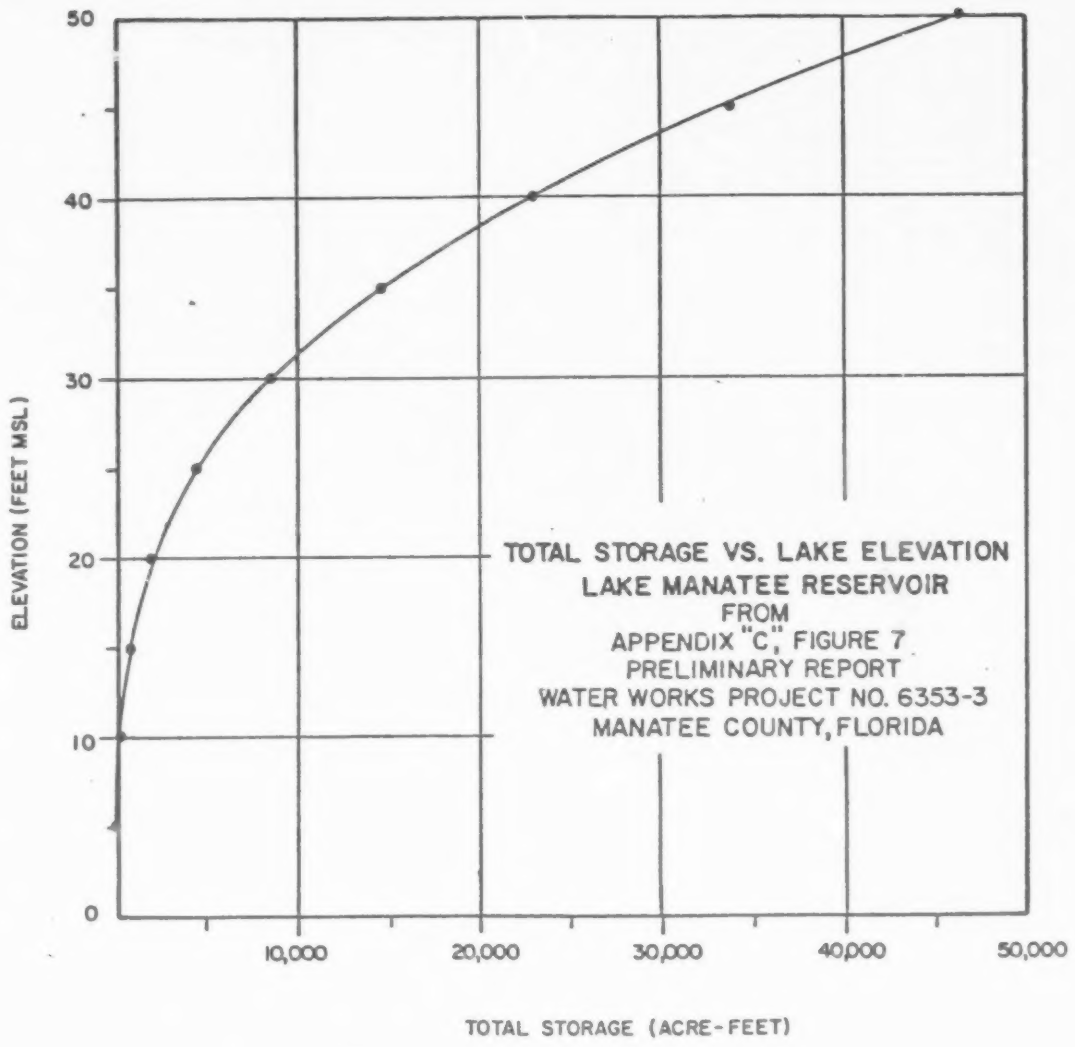


Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics,
Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: KC
CHECKED BY: [illegible]
DATE: 6/29/79
FILE NO. 74-027
APPROVED BY: Gregory Lee Adams

FIGURE 6



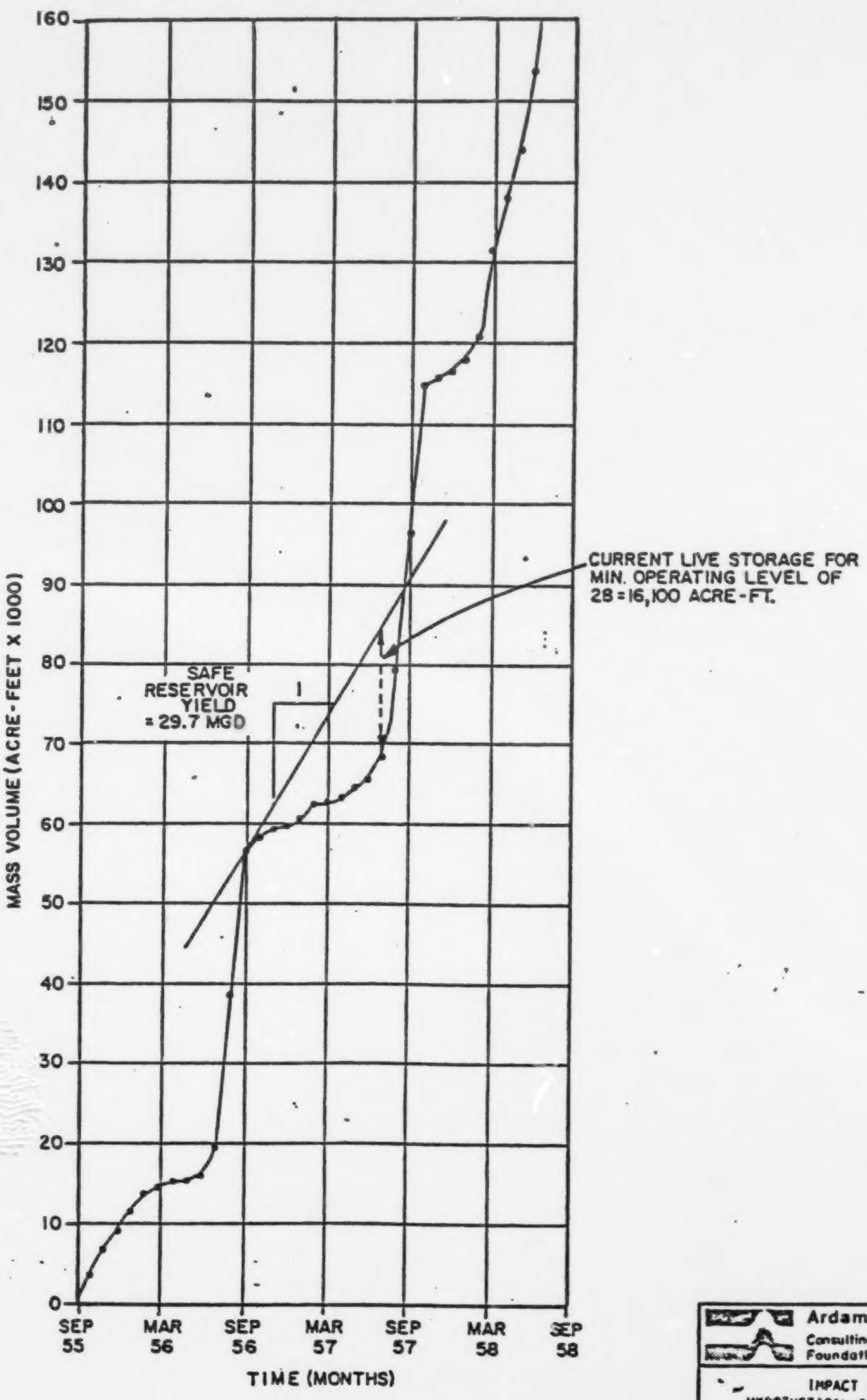
Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: K C
CHECKED BY: [illegible]
DATE: 6/28/79
FILE NO. 74-027
APPROVED BY: Gregory Lee Adams

FIGURE 7

MASS VOLUME VS. TIME FOR LAKE MANATEE



Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: KC	CHECKED BY: [illegible]	DATE: 6/29/79
FILE NO. 74-027	APPROVED BY: Gregory Lee Adams	

FIGURE 8

create an additional 24,000 acre-feet of live storage within the 86-foot contour interval by mining on either side of the 25-year floodplain of the East Fork Manatee River as shown schematically in Figure 9. Using this information, we have estimated that the total storage capacity of the Beker reservoir after mining would be approximately 31,500 acre-feet. The safe reservoir yield for the combined reservoirs was calculated to be 43 MGD.

Topography

Topographic information, including the slope of and cross-section across the Manatee River Valley, was obtained from U.S.G.S. topographic maps.

Analysis

The distance waste clay will flow if unrestrained by the settling area embankments or another obstruction is a function of the slope and cross-section of the land surface below the break, the shear strength and density of the clay, and the initial height and volume of clay in the settling area. The clay will flow as long as the shear stresses within the clay mass, which are a function of th height and slope of the mass. The relationship between undrained shear strength, S_u, density, γ, height, H, and slope angle, β, of the clay mass has been given in Figure 5, where $S_u/\gamma H$ is plotted against the maximum stable slope angle. For very long, flat slopes an approximate relationship between these variable is given by:

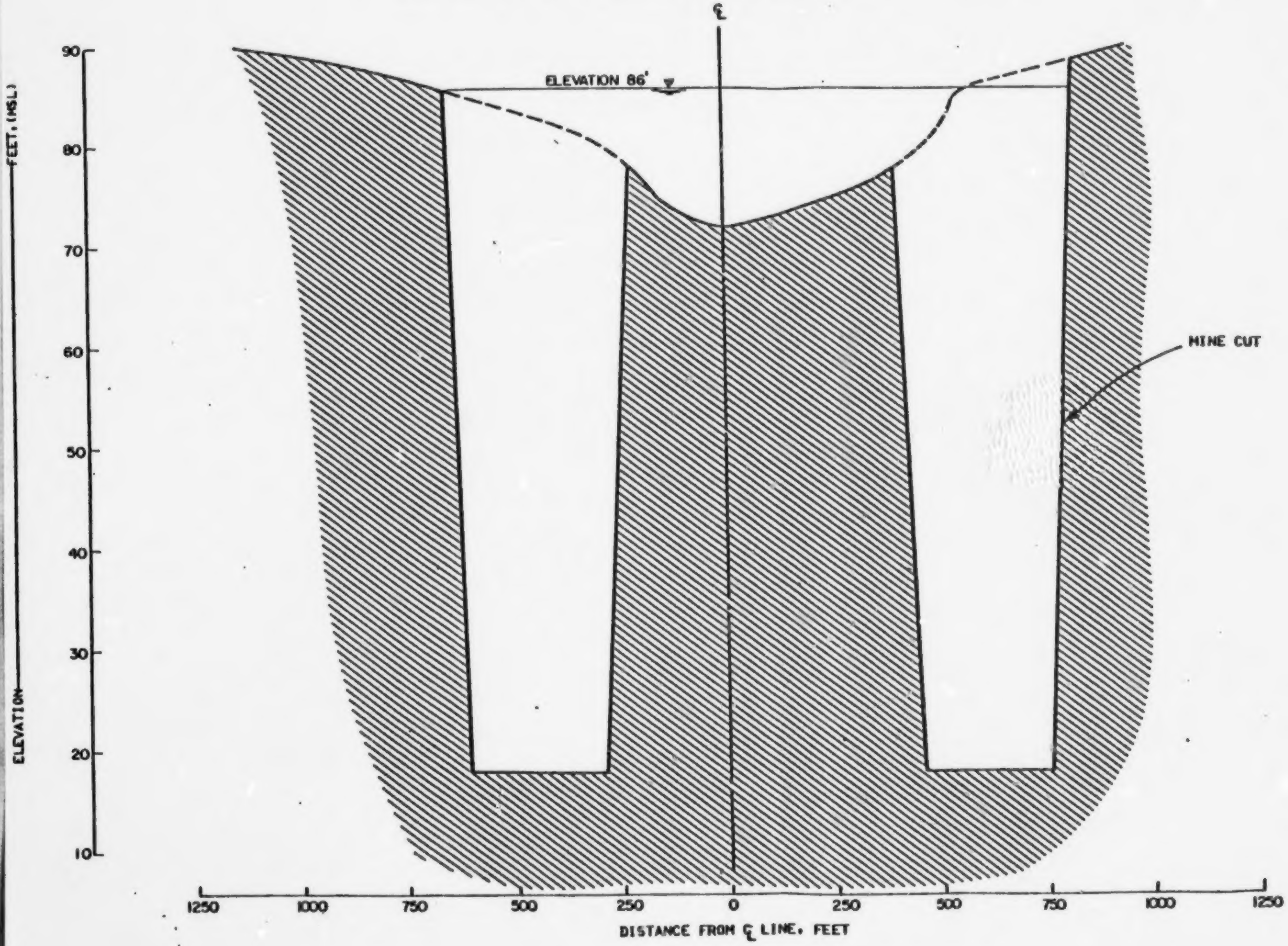
$$S_u/\gamma H = \tan \beta$$

With no obstruction, the clay will flow until the slope of the clay intersects the slope of the ground surface. Because the slope angle is a function of the height of the clay mass and the height must be such that the volume of material within the flowing clay mass is equal to the volume of clay released from the settling area, calculation of the distance to which the clay flows is, as described below, an interactive procedure.

Shear Strength Determination

Both the shear strength and density of the waste clay are related to the percent solids of the material within the settling area. The percent solids, as shown in Figure 3, is a function of the effective pressure applied to the clay. The effective pressure is the difference between the total applied pressure and the water pressure in the pores of the clay (see, e.g., Lambe & Whitman, pp 241 to 245). To determine the effective pressure with depth below the surface of the settling area, the degree of consolidation of the clay at the time of failure must be determined. Using the procedures described by Gibson (1958), and the coefficient of consolidation obtained from our laboratory test, the diagram in Figure 10 has been constructed. This diagram gives the total applied pressure and the pore water pressure distribution with depth in the settling area after 3 years. The difference between the two curves gives the effective pressure at any depth within the settling area at the assumed time of failure. Because the clay will continue to consolidate and strengthen with time, a failure at the end of the 3-year filling period would be a worst case condition.

SCHEMATIC CROSS SECTION OF PROPOSED BEKER RESERVIOR


℄
ELEVATION 86'
MINE CUT
ELEVATION — FEET, (MSL)
90
80
70
60
50
40
30
20
10
1250
1000
750
500
250
0
250
500
750
1000
1250
DISTANCE FROM ℄ LINE, FEET

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: CD
CHECKED BY:
DATE: 6/26/75
FILE NO. 74-027
APPROVED BY:

FIGURE 9

Using the effective pressures obtained from Figure 10 and the relationship between percent solids and effective pressure given in Figure 3, a graph (Figure 11) has been constructed giving the percent solids versus depth within the settling area for an initial solids content of 23.6 percent. Also shown on Figure 11 is a similar curve for an initial solids content of 18.2 percent.

To simplify the computations, each of the two curves in Figure 11 has been replaced with to straight line segments. The straight lines span depths from 0 to 13 feet and 13 to 23 feet, the thickness of waste clay after three years. These straight line segments are shown as dashed lines in Figure 11. For each waste clay sample a Liquidity Index, L_i has been calculated for the values of percent solids, S, represented by each straight line segment in Figure 11. The Liquidity Index is given by:

$$L_i = \frac{\omega - PL}{LL-PL},$$

where:

ω = Water Content = $\frac{100-S}{S}$
LL = Liquid Limit, percent
PL = Plastic Limit, percent

The values of Liquidity Index, as calculated above, were used together with the curve of undrained shear strength, S_u, vs. Liquidity Index presented in Figure 6 to obtain values of S_u representative of each of the straight line segments. The strength values are summarized in the table below:

TABLE 2

UNDRAINED SHEAR STRENGTH USED IN COMPUTATIONS

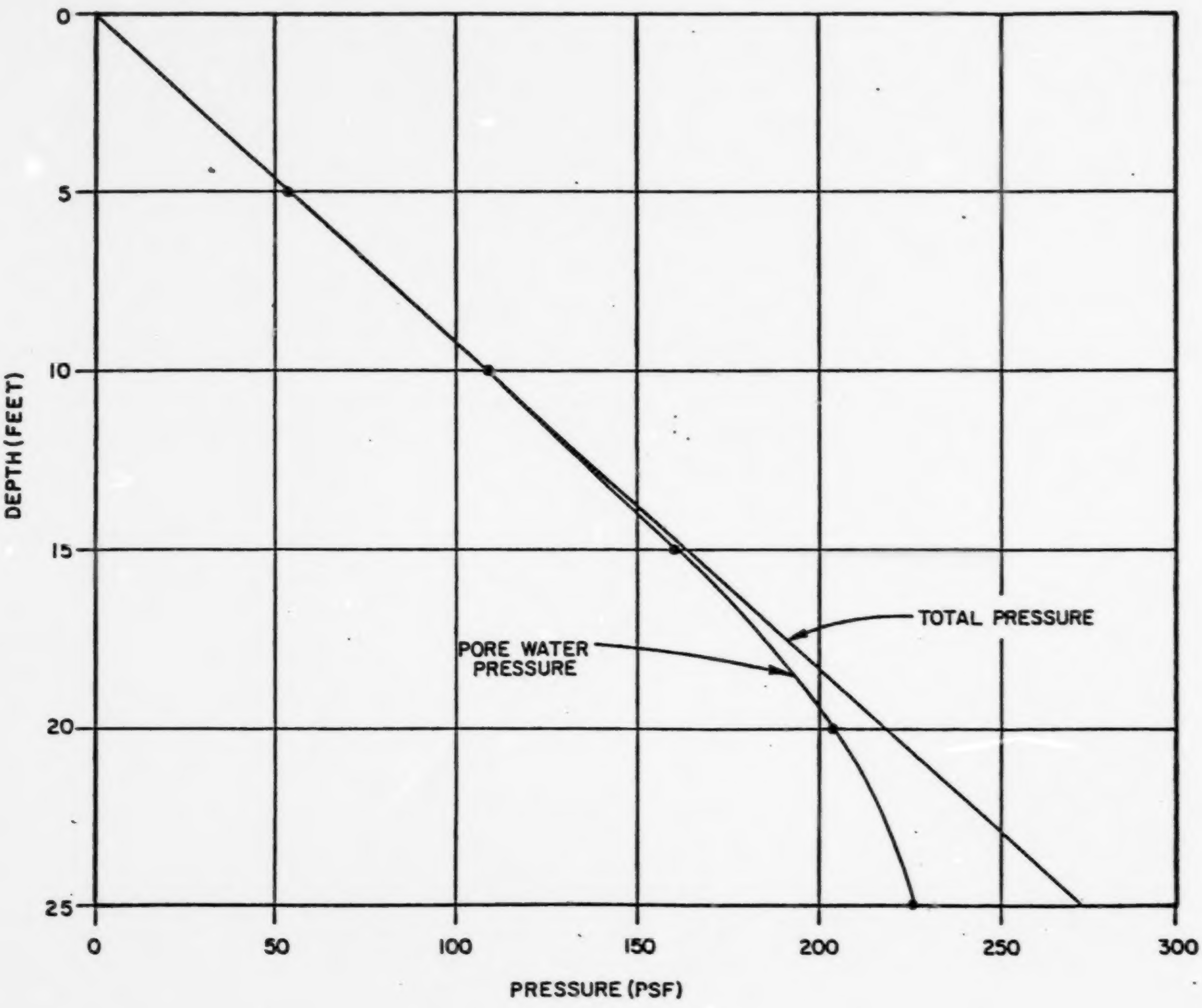
Depth (feet)	Sample No. 1	Sample No. 2
0 - 13	0.48 psf	0.32 psf
13 - 23	3.50 psf	1.30 psf

Computation of Waste Clay Distribution Along Manatee River

The iterative computations of the final waste clay distribution along the Manatee River were comprised of the following steps:

Step One: A slope height (depth of waste clay above the streambed centerline) was assumed at a point even with the assumed break in the settling area. To satisfy a worst case condition, the point chosen was along the west wall of the settling area in the vicinity of the steepest slope between the settling area and the streambed. This point is also among the closest of all possible break points to Lake Manatee (also a worst case condition), as it is near the southwest corner of the settling area.

PORE WATER AND TOTAL PRESSURE VS. DEPTH BELOW SETTLING AREA SURFACE AFTER THREE YEARS (INITIAL PERCENT SOLIDS = 23.6 %)

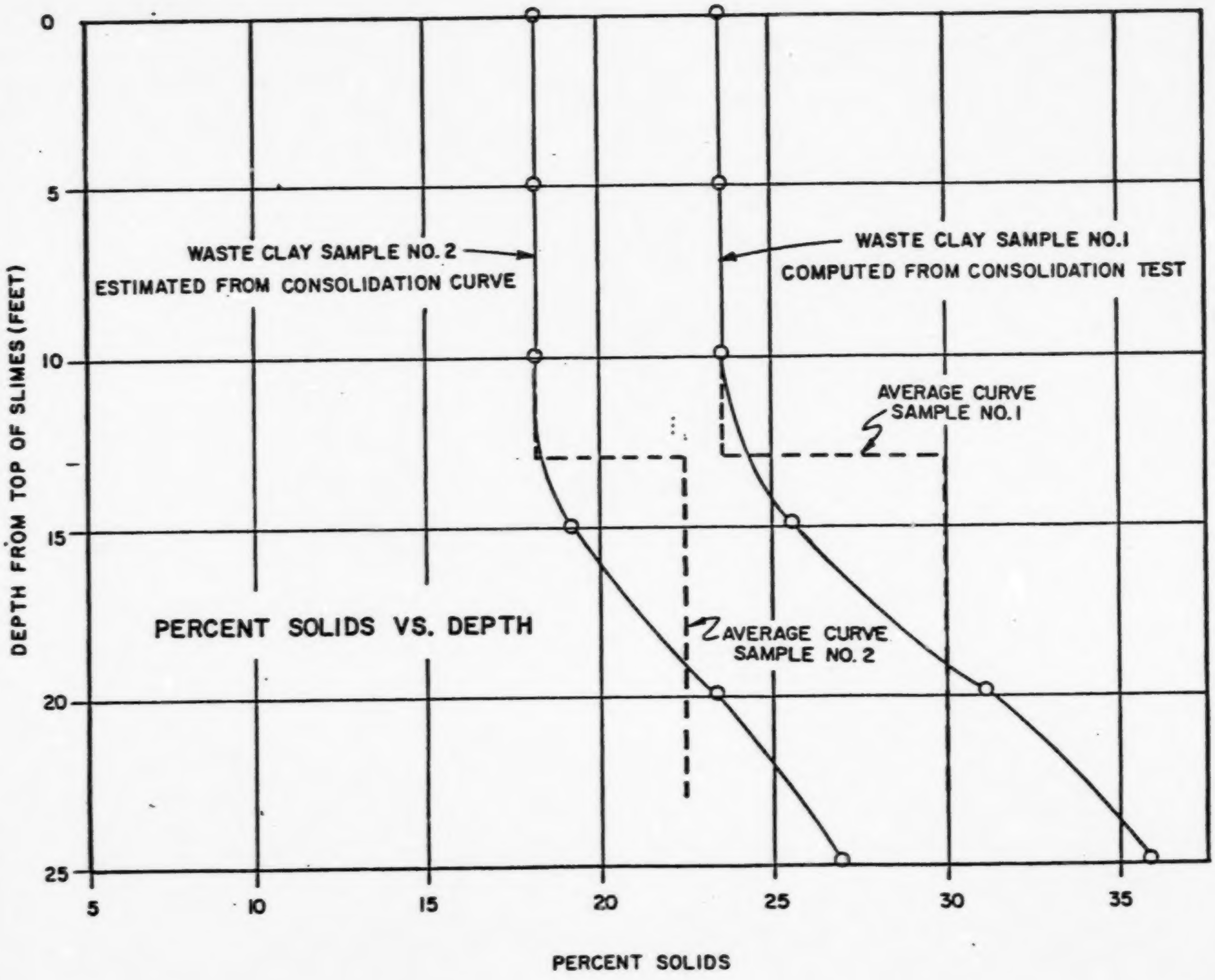


Ardaman & Associates, Inc
Consulting Engineers in Soil Mechanics
Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: KC	CHECKED BY:	DATE: 6/29/7
FILE NO. 74-047	APPROVED BY: Gregory Lee Adam	

FIGURE 10



Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

IMPACT EVALUATION OF
HYPOTHETICAL SETTLING AREA FAILURE
SWIFT - DUETTE MINE
MANATEE COUNTY, FLORIDA

DRAWN BY: KC	CHECKED BY:	DATE: 6/29/79
FILE NO. 74-027	APPROVED BY: Gregory Lee Adams	

FIGURE 11

Step Two: Using the shear strength values shown in Table 2 and the appropriate unit weights for the percent solids given by the straight line segments in Figure 11, the maximum slope angle between the settling area and streambed, the depth of waste clay at the settling area embankment, and the maximum slope angle of waste clay in the settling area were computed.

Step Three: The values computed in Step Two were then used to compute the volume of waste clay resting on the slope between the settling area and streambed and the total volume released from the settling area.

Step Four: The maximum slope angles of the clay mass along reaches of the river upstream and downstream of the assumed break point were then calculated and the termination points of the flowing clay mass upstream and downstream of the break determined.

Step Five: Using the slope angles, lengths of flow, and thickness of the waste clay calculated in Step Four, along with cross sections of the Manatee River Valley, the volume of waste clay distributed along the river was calculated.

Step Six: The volume of waste clay released from the settling area computed in Step Three was then compared with the sum of the volume of clay remaining on the slope between the settling area and streambed and the volume of clay distributed along the river valley. When these values did not agree a new initial height was chosen, and the computation steps were repreated until closure within a reasonable tolerance was obtained.

The distribution of waste clay along the Manatee River calculated for the iteration on which closure was obtained was taken as the correct distribution.

REFERENCES
TO APPENDIX E

Ardaman & Associates, Inc. (1975) "West Secondary Containment Structure; Beker Phosphate Corporation," File No. 73-696A, July, 1975.

Corps of Engineers (1978) "Phase I - Inspection Report, Lake Manatee Dam," Inventory Number FL280, Jacksonville District, February, 1978.

Gibson, R. E. (1958) "The Progress of Consolidation in a Clay Layer increasing in Thickness with Time" *Geotechnique*, Vol. VIII, No. 4.

Lambe, T. W. & R. V. Whitman (1969) *Soil Mechanics*, John Wiley and Sons, Inc., New York.

Manatee County Planning Department (1979) Personal Communication.

National Oceanic and Atmospheric Administration (1956) "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Area from 10 to 1000 square miles and Durations of 6, 12, 24, and 48 hours." Report No. 33.

Russell & Axon, Inc. (1979) Personal Communication.

Skempton, A. W. and R. D. Northey (1952) "The Sensitivity of Clays" *Geotechnique*, Vol. III, No. 1.

Taylor, D. W. (1937) "Stability of Earth Slopes" Journal of the Boston Society of Civil Engineers, Vol. XXIV, No. 3.

U. S. Geological Survey (1972) *Water Resources Data for Florida*, Vol 2, Water Quality Records.

Vanmarcke, Erik H. (1974) "Decision Analysis in Dam Safety Monitoring," Proceedings Safety of Small Dams, ASCE, New York.

Wischmeier, W. H., and L. D. Meyer (1973) "Soil Erodibility on Construction Areas" Highway Research Board Special Report 135, Washington, D. C.

Prediction of Suspended Solids Reduction in Lake Manatee following Hypothetical Clay Settling Area Embankment Failure

The procedure outlined below was used to predict what percentage of the suspended solids entering Lake Manatee following the hypothetical embankment failure would be removed from the water column by settling. For a period of two to three months following the spill, erosion of clays from the riverbed was estimated to add approximately 730 mg/l of TSS (Ardaman and Associates, 1979) to the background level at the head of the reservoir of 15 mg/l (Part I, Table 2-I). The specific objection of the following analysis was to estimate the TSS concentration that may be expected at the lower most intake structure to the Manatee County Water Plant given the 745 mg/l concentration at the head of the reservoir.

STEP 1: Determine particle settling velocity as a function of particle size.

It was determined through Reynolds Number computations (not shown here) that Stoke's Law (AWWA, 1971) was applicable under the given conditions to particles less than 70 microns in diameter which includes all of the concerned clay and silt particles.

For Reynolds numbers less than 0.3 Newton's general law of sedimentation reduces to the specific Stoke's Law":

$$V_C = \frac{g\,(\rho_S - \rho)\,d^2}{18\mu}$$

where
V_C= terminal velocity of particle
g = acceleration due to gravity
ρ_S= density of particle
= 144 lb/ft^3
based on a conservative value of specific
gravity for the waste clays of 2.3)
ρ = density of water
62.2 lbm/ft^3
(evaluated at 80°F

μ= absolute viscosity of water 0.578×10^{-3} lb_m/ft-sec (evaluated at 80°F)

Substituting ρ_s, ρ, and μ into Stoke's Law yields the following relationship between terminal velocity and particle size:

$$V_c = (2.514 \times 10^5)\, d^2$$

STEP 2: Using the known particle size distribution, construct a settling - velocity curve.

Figure 1 provides the laboratory test results of the particle size distribution determination (Ardaman and Associates, Inc., 1979 a). The test was performed on a sample of sand/clay waste taken from a pilot plant run on matrix from the proposed Duette Mine site. Note that, the so-called "waste clays" are, in fact, composed of particles predominantly in the sand and silt categories.

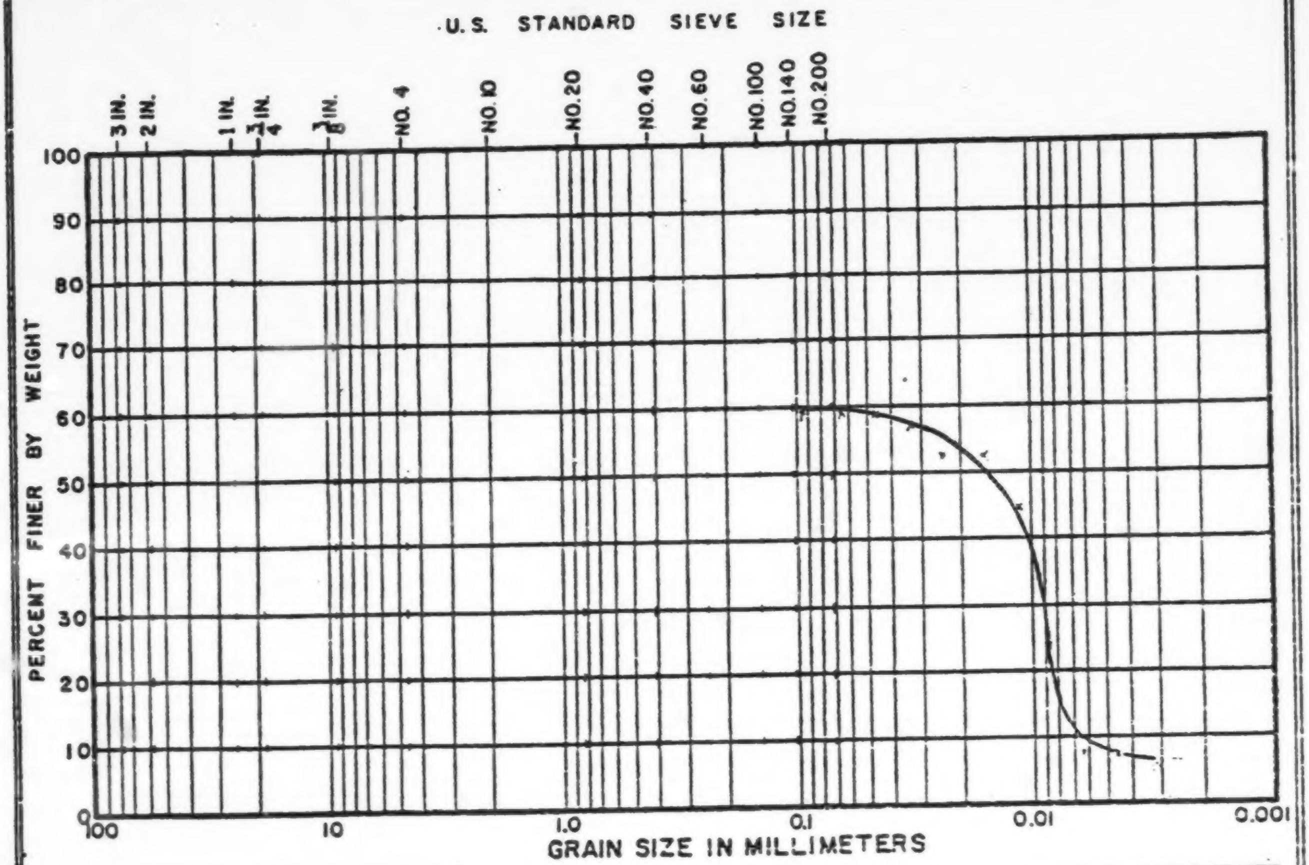
The velocity-grain size relationship developed in Step 1 was used in conjunction with the particle size distribution curve (Figure 1) to construct the velocity - settling curve shown in Figure 2.

STEP 3: Compute the terminal settling velocity necessary for a particle to settle through the full depth of the reservoir.

Assuming the Lake behaved as an ideal settling basin, the settling velocity necessary for a particle (entering the head of the reservoir) to settle to the bottom (at the dam) was computed as follows:

$$V_c = \frac{\text{Depth}}{\text{Detention time}}$$

Based on a reservoir volume of 16,000 acre ft (at the 36 feet elevation) and an annual average inflow to the reservoir 670 acre-feet/day from the entire watershed, the average detention time of a particle in the



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

TEST HOLE	DEPTH	SYMBOL	CLASSIFICATION	UNIFIED CLASS.
			Flocced Sand - Clay	ML
			Unif. Class. based on gradation only.	

Figure 1

GRAIN SIZE DISTRIBUTION CURVE

Zellars - Williams Pilot Plant
for
Swift Duette Mine

DRAWN BY: T. R.

DATE: 7-16-79

ARDAMAN & ASSOCIATES
ENGINEERING TESTING LABORATORIES

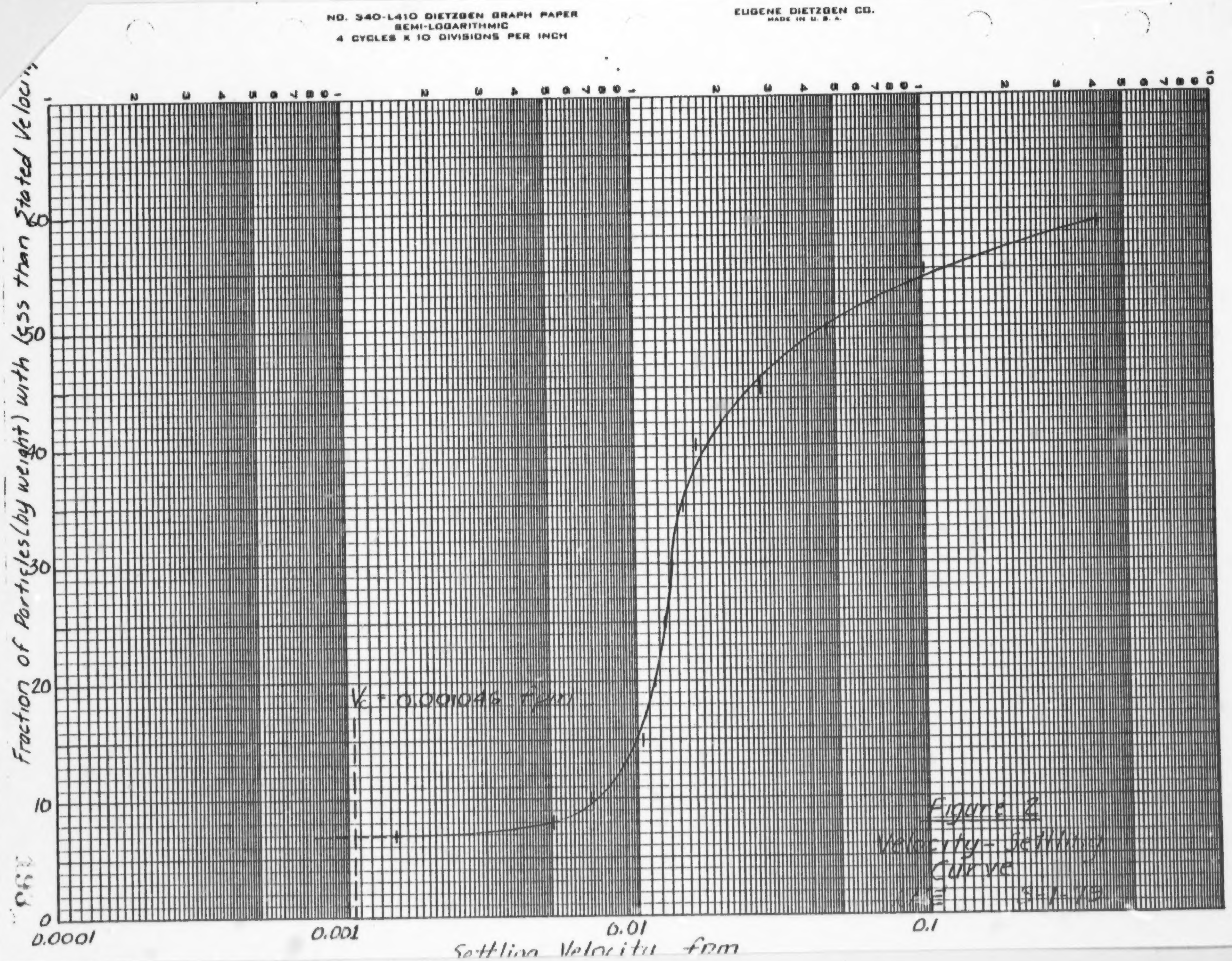


Figure 8
Velocity-Settling Curve
[illegible] 3-1-78

reservoir is 23.9 days.

$$V_c = \frac{36\ \text{feet}}{23.9\ \text{days}} = 1.506\ \text{feet/day}$$

$$V_c = 0.001046\ \text{feet/minute (fpm)}$$

STEP 4: Determine fraction of particles remaining in suspension.

The fraction of particles with settling velocities less than the critical 0.001046 fpm was then determined from Figure 2 to be approximately 7 percent. A slight extrapolation of the curve (shown dashed in Figure 2) was necessary.

The resultant predicted concentration of TSS at the intake structure is (0.07 x 245 mg/1) = 52 mg/1.